Facial Expressions of Emotion: Influences of Configuration

Fay Cook BSc MSc

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Date……………………………………………..

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ABSTRACT

The dominant theory in facial expression research is the dual mode hypothesis. After reviewing the literature pertaining to the dual mode hypothesis within the recognition of facial identities and emotional expressions, seven experiments are reported testing the role of configural processing within the recognition of emotional expressions of faces. The main findings were that the dual mode hypothesis can be supported within the facial recognition of emotional expression. This and other more specific findings are then reviewed within the context of extant literature. Implications for future research and applications within applied psychology are then considered.

Chapter One

PROCESSING OF FACIAL IDENTITIES AND FACIAL EXPRESSIONS

1 ABSTRACT

The purpose of this first chapter is to review published research which investigates the impact of configural and featural information and processing in both facial identity and facial expression perception. The two main theories of face processing are introduced, along with some of the supporting and conflicting research on these theories. It then goes on to introduce and review the main research methods employed to investigate the processing of identity and facial expressions. The final section, aims of the thesis, sets out the purpose of the present research and the structure which the thesis will follow.

2 INTRODUCTION

Research on face perception has been, and continues to be, one of the most thriving areas of investigation within psychology. Its scientific antecedents stretch as far back as 1649 (Bulwer) and encompass work by Galton (1883) and Darwin (1872, 1965). There is an inherent attraction to face research, with fundamental questions such as 'are faces special?' providing grounds for wide spread debate. However, there is an imbalance in knowledge between the two major fields of research regarding faces, those of facial identity and facial expressions. This imbalance is largely due to the domains of psychology in which the topics have been investigated. Research on facial expressions has primarily been conducted within the realm of social psychology, with an emphasis on the social-communicative value of emotional expression. This research has concentrated on such questions as whether facial expressions of emotion are universal, whether there are basic facial expressions of emotion, and whether the expressions are synonymous with underlying emotions. This is in stark contrast with research on facial identity, which is largely conducted in a cognitive psychology framework, with an emphasis on the perceptual basis for face recognition. Research in this area concentrates on such questions as- are familiar and unfamiliar faces processed similarly? What are the underlying mechanisms for face identification? And how are faces mentally represented?

The result of this imbalance is a dearth of information regarding the perceptual basis of facial expressions, numerous fundamental questions remaining unanswered and no detailed account available on how facial expressions are recognised (Calder et al, 2001). It has now been acknowledged by some researchers that this imbalance cannot continue (Calder et al, 2000a, 2000b, 2001; Campanella, 2002; Eimer & Holmes, 2002; Etcoff & Magee, 1992; Fox et al, 2000; Katsikitis, 1997;

White 1999, 2000, 2002; Young et al, 1997) and concerted efforts are being made to redress the problem.

One of the major questions that has been asked in both facial identity and facial expression research is 'what is the mode of processing for faces, is it configural, featural, or a combination of both?' The aim of the current thesis is to address this question for facial expressions and provide an investigation into the influences of configuration on emotional expression recognition via the face.

3 CONFIGURAL INFORMATION

Faces form a class of highly homogeneous stimuli, with the predominant internal structure of two horizontally aligned eyes, above a centrally placed nose, above a mouth. Whilst humans can recognise other homogeneous stimuli, such as tea cups or mugs, the ability of humans to recognise thousands of faces compared with much smaller numbers of other homogeneous stimuli is still an area of intense research. So the question is: how do humans do this?

The human face contains two primary sources of information, featural and configural. Featural information (also known as piecemeal, componential, analytic and part-based information) refers quite simply to the individual features of a face e.g. eyes, mouth, nose, chin, eyebrows, distinguishing marks e.g. moles etc. Configural information is much harder to define, as there is, as yet, no agreed upon definition. Diamond and Carey (1986) proposed that there are two types of configural information within a face, first-order and second-order information. The first order information is the configural information common to all faces, e.g. two horizontally aligned eyes above a nose, above a mouth. As all faces share this configuration it is proposed that it is second order relational information that specifies the differences between individual faces. This information can be thought of as the distances and inter-relationships between the features of a face.

The importance of configural information for facial identity recognition has long been established (Bruce, Doyle, Dench & Burton, 1991; Carey& Diamond, 1977, 1994;Lewis, & Johnston, 1997; Rhodes, 1988; Tanaka and Farah, 1991, 1993; Young et al, 1997). Now, with the recent increase in cognitive based research in facial expressions, the role of configural information for expressions has begun to be investigated.

4 THEORIES OF FACE PROCESSING

4.1 The Dual mode or Configural Hypothesis

The dual mode hypothesis of face processing is based upon the proposition that there are two types of information in a face and two types of processing modes specialised for encoding the information; these are configural and featural information and processing (Carey and Diamond, 1977; Diamond and Carey, 1986). Specifically the hypothesis proposes two routes to face processing which Searcy and Bartlett have summarised as “one mode is specialized for the encoding [of] spatial relational information, whereas the other is specialized for the encoding of components” (1996, p. 905). The hypothesis suggests that both configural and featural processing are employed with normal, upright faces whereas for inverted faces featural processing is the predominant mode. This is due to the fact that configural processing is largely disrupted by inverting a face, whereas featural processing remains intact.

Ingvalson and Wenger (2005) highlighted the fact that the hypothesis is based on three main assumptions: 1) configural and featural information are both available in a face, regardless of the orientation of that face; 2) the configural and featural information are processed independently; 3) the orientation of the face will determine which of the two sources will dominate the processing.

Evidence has been provided to support all three of the assumptions of the hypothesis and therefore to support the model itself. One of the most comprehensive studies of the dual mode hypothesis was that conducted by Searcy and Bartlett (1996). These authors tested the assumption that inversion disrupts the encoding of configural processing whilst leaving featural processing intact. One of the main criticisms levied at the dual mode hypothesis is that it is very difficult to make a configural change within a face and not impact upon featural information and vice versa, therefore these authors aimed to minimise this confound by employing a purely featural distortion and a configural distortion that would have minimum impact upon the featural information. The configural distortions involved moving the eyes up/down and the mouth up/down and featural distortions consisted of blackening the teeth, whitening the pupils in the eyes, reddening the eyes, and elongating or shortening teeth. A grotesqueness rating task was then employed, where participants were required to rate the grotesqueness of these different types of distorted faces when upright and inverted. This study revealed that participants rated the inverted configurally distorted faces as less grotesque than the same face when viewed upright, therefore revealing an impact of inversion upon the processing of configural distortions. This effect did not occur with featural distortions: these faces when inverted were still judged as showing the same level of grotesqueness as when they were viewed upright, therefore resulting in the conclusion that inversion does not affect the processing of featural information. Searcy and Bartlett went on to show that inversion also increases response latencies when participants are asked to detect configural differences but the latencies for detecting featural changes are not affected. Further, these authors also showed that in a comparison task (are these faces identical or not) response latencies were increased when the faces contained configural distortions but not when they contained featural ones. These results therefore support the third assumption of the dual mode hypothesis, that orientation will determine which mode of processing is employed. As inversion disrupted the processing of configural information in these experiments and not featural processing, it can therefore be concluded that featural processing is dominant in inverted faces.

Prior to this the same researchers (Bartlett and Searcy, 1993) had tested the dual mode hypothesis against various other explanations for the inversion effect (i.e. reduced recognition with inverted faces). In this series of studies Bartlett and Searcy found that participants employed both configural and featural processing with upright faces, however, with inverted faces configural information was disrupted to such an extent that featural information was relied upon. Therefore providing evidence for the first and third assumptions of the dual mode hypothesis theory.

Cabeza and Kato (2000) provided support for the dual mode view whilst investigating another theory of face processing-the holistic theory (see page 7). Unlike the dual mode hypothesis the holistic theory of face processing does not allow for featural processing. Tanaka and Farah (1993) who proposed the theory suggest that faces are processed as unparsed wholes, with no representation of individual features. Cabeza and Kato (2000) authors employed the prototype effect to examine the holistic theory - this effect is the 'tendency to falsely recognize a new face that is perceptually related to a series of seen faces' (p. 429). By employing prototypes which either emphasised featural or configural information the contribution of featural and configural processing was assessed. Featural prototypes consisted of previously studied features in a new configuration and configural prototypes retained the original studied configuration but with slightly distorted features. However, it is important to note that these changes were not absolute, that is, the featural changes could have caused configural changes and vice versa; although the featural prototypes did preserve featural information more than the configural information and likewise the configural prototypes preserved configural information more than featural information. If the holistic hypothesis was to be supported with the prototype effect, Cabeza and Kato expected that they would get a prototype effect (i.e. false recognition of prototypes that had been studied before more than prototypes which were new) for the configural stimuli but not for the featural ones. For support of the dual mode hypothesis, a prototype effect for both the configural and featural stimuli would be needed. Evidence was found in support of the dual mode view as participants incorrectly recognised both featural and configural prototypes as faces previously seen. This therefore supports the second assumption of the dual mode hypothesis, that featural and configural information are processed independently in faces. Cabeza and Kato (2000) therefore propose that both configural processing and featural processing make important contributions to facial identity processing. It was also found that when the prototypes were inverted, the featural prototypes continued to be ‘recognised’ as having been seen before, but this did not occur for the configural stimuli, supporting the assumption that orientation impacts upon which mode of processing is employed. Also, when participants were asked to make similarity judgements between two faces, performance was good in the upright condition when judging one configurally manipulated face against an unmanipulated face, or another configurally distorted face; however, when presentation was inverted participants responded correctly to only half of the trials. The evidence accumulated by Cabeza and Kato (2000) therefore supports all three of the assumptions of the dual mode hypothesis.

The dual mode hypothesis has received a large amount of interest from the facial identity research community, with many researchers setting out with the purpose of providing evidence for an alternative theory for face identification processing and finally concluding that the dual mode hypothesis is the dominant theory.

4.2 The Holistic Hypothesis

Tanaka and Farah (1993) propose that face processing is accomplished by a holistic processing mechanism, where faces are encoded as unparsed wholes. In this holistic representation although the individual features would be included and present in the face representation, they are not explicitly represented. So, although features would be included in the processing of a face they would not be processed as ‘parts’ in their own right. However, the authors do acknowledge that the holistic theory does not rule out a dual mode approach (whereby both featural and configural information are processed) as both features and configural information may be used but to different extents. Due to this acknowledgement Tanaka and Farah rephrase the holistic question to address the issue of whether faces are processed more holistically than other forms of objects. Tanaka and Farah suggested that if features are explicitly represented in faces (i.e. not holistic representations) then recognition of an individual feature would be easier when presented in isolation, due to the fact that they would be represented as parts in their own right. If however, as the holistic theory suggests, features are not represented explicitly in the face, then recognition should be easier when features are presented in a face compared to in isolation. The three experiments that these authors conducted did support these assumptions. Participants were less accurate at identifying parts of faces (eyes, nose and mouth) when presented in isolation compared to when they were presented in a whole face. However, Tanaka and Farah do admit,

> “the concepts of configurational representation and holistic representation are highly similar, and possibly identical” (pg. 242).

Thereby acknowledging that the research could be taken as evidence for both a holistic and configural face representation and processing strategy.

One of the implicit assumptions of the holistic hypothesis was tested by Tanaka and Sengco (1997) when they looked at the impact of changes in configuration upon the retrieval of features. According to the holistic theory, where features and configuration are inextricably linked, any change or disruption to the configural information will also impact upon the ability to represent and retrieve the featural information. Tanaka and Sengco supported this assumption by investigating participants’ ability to retrieve featural information under different conditions when configural information had been altered. Consequently the authors found that participants could recognise features best when they were presented in their original configuration (as they were seen in the study phase of the experiment), next best when the features were put into a new facial configuration and were recognised the least well when presented in isolation. Further experiments also revealed that configural processing occurred with upright but not inverted faces and that configural changes were attended to in faces but not houses. Tanaka and Sengco therefore provided evidence for this important tenet of the holistic hypothesis, that featural and configural information are represented together and change in one affects the other. However, one important point which was not addressed by this study is the fact that the faces were still recognised well with a new configuration, but original features. With the large body of research that suggests that configural processing is important for face recognition, this result seems to imply that featural information is in fact represented in memory and this information, although affected by configural change, is still available and is processed to achieve recognition. Tanaka and Sengco (1997) do acknowledge that the isolated features were recognised at above chance levels and therefore were represented to some extent, and were encoded independently of the other features and configurations; which therefore leads to the question of where this leaves the holistic hypothesis. This question is not addressed by the authors, but it would seem that it contradicts the holistic hypothesis which states that features are not represented as parts in their own right, only as an unparsed whole with the face.

Tanaka and Farah have continued to research the holistic hypothesis (Farah, Wilson, Drain & Tanaka, 1998). They found evidence for relatively less part based representations of faces; however, they again did not rule out part based representations entirely. In a same-different matching task, participants were required to view two faces and then saw the name of a face part e.g. nose displayed on the screen; their task being to say whether that feature in the previously viewed faces had been the same or different. The reasoning behind this study suggested that if faces were based on part representations, then participants should have been able to compare the memory representation for the feature with relative ease and very little interference from the other features in the face. Regardless of how many features are the same or different in the face, the overall perception of (dis)similarity in the whole face should not interfere with the task. If, however, the representation is holistic then the representation of the face will also include the degree of similarity or dissimilarity between the two faces, which would interfere with the task of comparing two parts. Farah, Wilson, Drain and Tanaka (1998) do add a clause to their argument, which makes the proposition seem somewhat redundant, and it is that

> "Of course, face representations are unlikely to be either pure holistic representations with no explicit part-level representations (especially in the context of the present task's demands) or pure collections of parts with no explicit whole-level representations" (pg. 486)

Part matching was compared between upright and inverted faces as upright faces are thought to engage the holistic face specific representation but inverted faces do not. It was found that the holistic hypothesis was supported; participants did have more trouble matching parts in upright faces compared to inverted faces. However, these authors actually investigate the relative *contribution* of part and whole representations to faces. The results therefore propose that relative to other stimuli, faces are represented holistically; again, however, the authors acknowledge that this means with little or no part decomposition. They do not suggest that part representations are not involved with face perception, therefore the results from this study can be conceived of as a stronger version of the dual mode hypothesis.

By studying the ability to represent and store a single feature in memory, Macho and Leder (1998) also provided an investigation of the holistic hypothesis. According to the holistic hypothesis it is not possible to store the representation of a single feature in memory as features are not explicitly represented as parts in a face; rather they are encoded as part and parcel of the unparsed face. The features that were used in this study were nose width, eye distance and size of mouth and the participants' task was to 'match' the face representation to one of two target faces based on the similarity of the test face to the target faces. These authors rejected the holistic hypothesis as participants could store representations of single features in memory. Therefore the results these authors found provide evidence contrary to the holistic hypothesis, but support for the *dual mode theory* of face processing, as it was found that participants could represent individual features in memory and the dual mode suggests that featural processing can occur under some conditions. The features were also shown in a face context and it is therefore possible that participants were storing the unique configural information of the face rather than just featural information alone and employing configural processing. Further, the study also actually tests memory for features that could be considered second order configural features (i.e. interrelationships of features, such as eye distance); and therefore the research could be taken as providing evidence that representations of parts of configurations can be stored in memory and not features per se.

Although the above studies do provide support and evidence for the holistic hypothesis, there remain problems with the theory. The primary concern is the lack of distinction between holistic and configural information, with all of the above studies conceding that the results could (and do) provide strong support for the configural processing of faces as well as the holistic processing of them. Without a strong and clear distinction between what is configural and what is holistic the above studies continue to provide evidence for both forms of processing with faces. There are also problems with the proposal of the hypothesis that faces are not represented according to their constituent parts, and that the features of faces are not explicitly represented at all, other than as part of the whole. The fact that some of the authors working on this hypothesis choose to re-phrase the hypothesis to look at the relative contribution of holistic processing in faces compared to other objects (Tanaka and Farah, 1993) goes to highlight this problem further. Indeed, each paper cited above qualifies their conclusions by acknowledging that part based representations and processing cannot be ruled out. Therefore, a more 'moderate' holistic hypothesis has come from the research. However, this is extremely similar to the dual mode hypothesis considered above.

5 CONFIGURAL PROCESSING OF FACIAL EXPRESSIONS

A large body of research has been built up which proposes that facial identity recognition and facial expression recognition are in fact dissociable (Bruce and Young, 1986; Campbell 1996; Herrmann Aranda, Ellgring, Mueller, Strik, Heidrich & Fallgatter, 2002; White, 2002). Whilst research on facial identity suggests that configural information (specifically second order) is the primary means by which faces are recognised and/or processed, there are conflicting reports on the configural/featural divide regarding facial expressions, which adds to the proposition of dissociability. There have been more 'theories' or hypotheses proposed for facial expression perception than facial identity, and perhaps this is due to inconsistency within the research. For example, many researchers in the facial identity area research identity processing as their primary interest, whereas for facial expression researchers tend to dip 'in and out' of the area; this means that many hypotheses are never fully tested and explored. This has led to many hypotheses being suggested but few theories having been built.

Ellison and Massaro (1997) report findings for facial expression recognition in complete conflict to those found with facial identity.

These authors propose a part-based model for facial affect recognition, where expressions are both represented and identified in terms of their constituent features. Employing a computer generated face system Ellison and Massaro manipulated two facial features, eyebrow deflection and mouth deflection, independently and in a highly controlled way in order to assess the holistic perception of facial affect. Participants were asked to decide if the face was displaying a happy expression or an angry expression, and participants completed both a forced choice task and a ratings task. Responses to whole face stimuli containing both featural manipulations were assessed, as were responses to corresponding half face stimuli. The authors found that both eyebrow deflection and mouth deflection could alter the participant's perception of the facial expression from happy to angry and when one feature was ambiguous or missing the influence of the remaining feature was larger. It was found that by employing the fuzzy logic model of perception (Massaro and Cohen, 1990, 1993; Massaro and Ferguson, 1993) participants' responses to the whole faces could be predicted from their performance with the half faces, which contained only a single variable feature (e.g. top half faces contained only the eyebrow and bottom half only the mouth). Ellison and Massaro (1997) therefore conclude that the results are in conflict with a holistic model of facial expression perception, where all features interact and are perceived in a gestalt, and are instead consistent with a feature or part based model where expressions are represented and identified by their individual features. Whilst it would also seem that this research rejects the configural processing of facial expressions as well as holistic processing, the authors do acknowledge that although they did not find support for configural processing it is possible that it does occur. Further, they suggest that the spatial representation of facial expressions (as in the configural hypothesis) would probably not include the two features manipulated in the study (eyebrows and mouth corners) as their model suggests that the two features are recognised from individual featural evaluation and not configural processing. However, the authors do concede that configural processing of these features must be true at some level and propose that

> "For example, the deflection of the corner of the mouth is probably evaluated relative to the centre of the mouth. The deflection of the eyebrows could be evaluated relative to the eyes and nose." (page 222).

Thus, contradicting their model and suggestions.

Calder, Young, Keane and Dean (2000b) point out that because only two features were employed in the Ellison and Massaro study it is possible that participants may have represented these as individual features or even objects and not integrated them into a configuration. This would also be further impacted by the use of a highly stylised computer generated face in which no global changes occurred. For example, in a real life face when the eyebrows are raised the forehead also becomes wrinkled, and similarly the cheeks and chin are affected by a mouth deflection; however, the computer generation did not show these changes. Therefore a lack of change to the whole face, or face configuration, could have added to the perception of these features as individual. Such a model as the one proposed by Ellison and Massaro (1997) is in direct opposition to facial identity research where featural information is not considered to be as influential as configural information.

Research reported by Bartlett and Searcy (1993) investigated the impact of inversion on facial expression processing. Research suggests that when a face is inverted the configural processing mechanism is disrupted (see below) which impacts upon the identification and recognition of facial identity; however, Bartlett and Searcy found that expression encoding was not as affected by this manipulation. They found that certain facial expressions were recognised as well when inverted as when upright, therefore concluding that some facial expressions are based on identifiable components. Again providing some support for a feature based system (although overall support is found for the dual mode hypothesis).

A part based representation theory for facial expression is also proposed to be supported by the success of a facial expression scoring technique developed by Ekman, Friesen and Ellsworth (1982). This technique ‘splits’ the face into separate areas that are then scored for the expression they are displaying; the areas include the forehead, eyes and mouth. This technique has found high rates of success using independent coders and it therefore also supports the idea that separate areas, if not features, can be employed for facial expression representation. Of course, the whole basis upon which this system is built is indicating to the participants or coders that they are expected to judge or rate the expression in a separated part of a face. By focusing someone's attention on a single part of a face it cannot be concluded that expressions are part based, rather, that when asking people to rate an emotional expression in a single area of a face, scores are highly correlated. This is a different conclusion and one that should not be taken as evidence for a part based theory or model of facial expression processing.

Some research suggests that configural information is as important for facial affect judgements as it is for facial identity recognition (Parks, Coss & Coss, 1985). Parks et al. (1985) investigated the effect of context on the processing of facial features. Participants were asked to rate the pleasantness of *either* eyes or mouths that were either presented in isolation or in conjunction with the other feature; participants were instructed to only rate one feature and not both together. The mouth was either presented upright or inverted, and the eyes were placed either above or below the mouth. This arrangement therefore resulted in the suggestion of four possible face contexts: an upright face context (upright mouth with eyes above), an inverted face context (inverted mouth with eyes below), an upright Thatcher illusion (inverted mouth below normal eyes-see below the next chapter for a review of the Thatcher illusion) or an inverted Thatcher illusion (upright mouth above eyes). It was found that when the eyes and mouth were placed in a facial configuration, the judgement of appearance could be altered, compared to when the feature was presented in isolation. When an inverted mouth was presented with a pair of eyes below it, suggestive of the configuration of a normal inverted face, the perception of grotesqueness in this condition was reduced in comparison to the same mouth with eyes placed above it (like a Thatcher face). Similarly, when the eyes were placed above an upright mouth so that the resulting ‘expression’ was one of happiness/smiling/pleasantness, the rating for pleasantness was increased. In a second experiment the authors found that the rated pleasantness was also affected by the distances between the eyes and mouth, and this would seem to be a configural property of a face, in particular a second order configural property. This study therefore suggests that even when participants are directed to process only one feature, the face configuration interferes with the processing of that feature and encourages configural processing of a ‘face context’.

A further line of research also proposes that facial expressions are reliant upon configural information, but rather than the second order information which is pertinent for facial identity, first order information is important for facial expressions. Calder et al. (2000b) investigated the composite effect (see the next chapter for a review of this manipulation) for facial expressions and found that the configural information for facial expressions and facial identity could be selectively disrupted. They concluded that the configural information important for facial identity and that for facial expressions is possibly different. These authors suggested that the coarser first order information (e.g. two eyes, above a nose, above a mouth) could be more important for facial expressions whereas the second order, spatial relational information is used for facial identity processing. They proposed that facial expressions might be encoded using a 'typical/average configuration' for the expression e.g. for surprise: raised eyebrows, wide-open eyes and an open mouth. Further to this research, White (2002) employed a categorical manipulation that disrupted first order information more than second order. By moving one eye up into the forehead region of a face, the first order configuration of the face was manipulated (i.e. the two eyes were no longer horizontally aligned above the nose, above the mouth) whilst only minimally disrupting the second order information (the spatial relations in the face were only minimally impacted as one eye did not change position). The result of the first order manipulation was reduced accuracy with expression matching, but no effect on identity matching. White also found that by moving both eyes into the forehead region (thereby changing the second order information but leaving first order configuration unaltered) accuracy of identity matches was reduced whilst expression matches were not. White therefore proposed that facial expression recognition is more akin to basic level object recognition that is reliant upon categorical or first order information, rather than facial identity recognition which is reliant upon second order information. However, one problem with the White (2002) study is the use of only four facial expressions of emotion, which leads to problems with generalised conclusions regarding all expressions.

It is important to note however, that these studies that support the configural processing of facial expressions do not exclude featural processing. Instead the authors concur with the configural or dual mode hypothesis, and suggest that under normal circumstances configural processing is the dominant mode employed with facial expressions. Whilst also acknowledging that featural information is important and featural processing is employed under certain circumstances and for certain tasks.

In contrast, or as a compromise to the lines of research above, McKelvie (1995) and Prkachin (2003) propose that recognition/perception of a facial expression is reliant upon both types of information (configural or dual mode hypothesis), but that there are possible dissociations for certain expressions, with different expressions being more 'featural' or more 'configural' based. McKelvie (1995) found that happiness, surprise and neutral facial expressions were not impacted by the configural manipulation of inversion and therefore concluded that these facial expressions could be based on identifiable, individual components (such as the wide open eyes of surprise or the smiling, upturned mouth of happiness) which are insensitive to inversion. Whilst Prkachin (2003) did find an inversion effect (i.e. reduced accuracy with inverted faces) for all six of the basic facial expressions of emotion, she noted that the expressions of happiness and surprise were the most accurately recognised when upright and the least affected by inversion. Prkachin therefore also suggested that these expressions could be based more on featural information rather than configural that would be disrupted by inversion.

5.1 Summary

Whilst there has been a recent surge in research on the effects of configural manipulations upon facial expressions, no definitive conclusions have been reached. It would seem that configural information does have a role in facial expression perception, but the nature and extent of its influence are still under consideration. The majority of researchers investigating the primary processing strategy for facial expressions conclude that both configural and featural processing are important under different conditions, with the dominant mode of processing being configural. The primary aim of the present research is to investigate the effects of configural and featural manipulations upon facial expression perception, investigating the impact on each of the six basic facial expressions.

6 INVESTIGATING FACIAL EXPRESSIONS

Due to the differing domains of psychological research in which face perception is studied, there is no 'tried and tested' methodology for the cognitive investigation of facial expressions. However, methodologies are in abundance for facial identity research; so it is these that are now being used to research expression perception. In order to access the way in which faces are perceptually represented it is necessary to tease apart the information that humans extract from them, to this end numerous manipulations have been applied to face stimuli. Such methods include using composite faces (Calder et al, 2000b; Young, Hellawell & Hay, 1987), stimulus orientation (Freire, Lee & Symons, 2000; Levin & Beale, 2000; McMullen, Shore & Henderson, 2000; Murray, Yong & Rhodes, 2000; Rakover & Teucher, 1997) caricaturing (Benson & Perrett, 1999; Calder et al, 2000a), and visual illusions, such as the Noh mask (Lyons et al, 2000a, 2000b) and the Thatcher illusion (Lewis & Johnston, 1997; Lewis, 2001; Muskat & Sjoberg, 1997; Thompson, 1980; Valentine & Bruce, 1985). Other effects include scrambling or jumbling faces (Rakover, 1999), applying noise, pixilation or blur (Collishaw & Hole, 2000; Lander, Bruce & Hill, 2001; McKone, Martini & Nakayama, 2001) negation (Hole, George, Dunsmore, 1999; Kemp, Pike, White & Musselman, 1996; White, 2001) and feature displacement (Bartlett & Searcy, 1993; Searcy & Bartlett, 1996; White 2002). Due to the extensive research conducted with these experimental methods and the robust effects found with facial identity perception, they are accepted as empirically viable methods to be applied to facial expression research; and indeed, they are being applied. These methods provide a way of researching facial expression perception using reliable methodology, whilst also providing a way to compare facial identity perception with facial expression perception.

6.1 Methods for Studying Modes of Processing

One of the challenging aspects of research with normal faces is actually accessing, manipulating and isolating configural information. Four common methods for researching configural processing in faces are the facial inversion effect, the Thatcher illusion, the composite effect and filtration/spatial scale manipulation. All of these methods have yielded evidence that face processing is highly reliant upon configural processing.

6.1.1 The Facial Inversion Effect

The facial inversion effect is one of the most striking effects that can occur with faces, whereby recognition is severely impaired with an inverted face and distortions within the face become much harder to detect. The disruption to recognition is much greater for faces than for other mono-oriented stimuli (items which are seen in one orientation more frequently than in any other orientation) such as houses, stick figures (Yin, 1969) dog faces, buildings (Scapinello & Yarmey, 1970) landscapes and dog breeds (Diamond & Carey, 1986). The difficulty of detecting changes to a face can also be extremely dramatic with inverted faces, with participants failing to notice inverted features (Thompson, 1980-the Thatcher illusion) or spatial distortions (Bartlett & Searcy, 1993). The facial inversion effect has been subject to numerous investigations since it was first highlighted in 1969 by Yin.

When faces are inverted no actual change occurs within the face, the features remain the same, in the same position, the configural information between the features is unchanged and the overall configuration of the face remains intact. So what does happen when a face is turned upside down? The overriding consensus that has emerged from a large amount of research is that configural *processing* is disrupted with 180 degree rotation, and therefore facial information is no longer processed configurally, as it is when the face is upright.

One of the main reasons for believing that the inversion effect disrupts configural processing is the effect of inversion upon identifying changes to a face. It has been found that if the eyes and mouth of a face are inverted within the face, the resulting face appears grotesque, strange, weird, ugly, funny, and numerous other descriptors (Lewis, 2004). However, when this resultant Thatcher face (Thompson, 1980) is inverted, this strange perception disappears, and participants become almost unaware of any difference in the face (Bartlett & Searcy, 1993; Thompson, 1980). When matching studies have been conducted between Thatcherised faces and normal smiling faces, participants have judged these two face types to be very similar when inverted, but very dissimilar when upright (Bartlett & Searcy, 1993). It has been suggested that this is because when the face is upright it is processed configurally and it is apparent that the configuration of the face does not fit with that of a normal face; however, when inverted, configural processing is disrupted and therefore featural information is relied upon. In the inverted face, the featural information is in fact unchanged-the eyes and mouth are now presented upright, and therefore the perception of a strange face disappears, as the features are being processed and not the face configuration.

Similarly, if the positions of the features of a face are altered the change is not detected as readily when the face is inverted as when upright. Rhodes, Brake and Atkinson (1993) looked at feature spacing, which consists of moving the eyes and mouth up or down relative to their normal position. This does not affect the featural information per se but it does alter the configural information (second order) in the face, as the interpositions and distances between the features are no longer the same. Using an old-new recognition task participants were instructed to indicate which of two faces (one original and one manipulated) they had seen before. It was found that coding of the spatially distorted faces was severely impaired by inversion-as was that of Thatcher faces. However, coding of isolated feature change faces was not so affected. The authors propose that this is due to the featural processing which is elicited with inverted faces; the changes to the spatial distortion faces are second order relational changes, which are not easily coded in an inverted face which is being processed featurally (no feature change takes place in these faces). Rhodes et al. (1993) cite this study as direct evidence for the idea that inversion disrupts configural processing more than featural, and provide evidence for the dual mode hypothesis of face processing. Whilst the authors do acknowledge that one of their feature changes (feature swap) is problematic as participants tended to automatically process the second order information available in these faces, they fail to acknowledge that the presence/absence of glasses as their other featural manipulation is also problematic. The addition of an extra (non-facial) feature is likely to make a face distinctive (Baenninger, 1994) and it is possible that this would not be coded as a featural change, therefore the lack of inversion effect for isolated features could be due to processing of 'external' cues (e.g. distinctiveness of the resultant face) rather than featural information per se.

Sergent (1984) also provided direct evidence of the configural processing of upright faces compared to inverted ones. Measuring response latencies in a matching task with photo-fit faces Sergent found that when faces were presented upright the distinguishing features interacted in a configuration and were thus processed configurally (and in parallel). When the faces were inverted there was no evidence of feature interaction and they were therefore processed independently and analytically (serially). It was also found that internal spacing (a relational property) of features was processed differently in upright and inverted faces; whereas the contour of the face and the shape of the eyes (featural properties) were processed in the same manner regardless of orientation. Therefore this study provides direct evidence of the different processing strategies employed for upright and inverted faces, namely configural and featural processing.

Employing the composite effect for faces has also provided evidence for a disruption in configural processing with inverted face stimuli (See below for a review of this method).

Freire, Lee and Symons (2000) have also examined the facial inversion effect. In contrast to most research on face processing these authors employed only one face stimulus in their studies to reduce the influence of configural and featural differences between stimuli that cannot be controlled for when employing a number of faces. The impact of inversion upon faces that differed primarily in configural information or featural information was examined in the study. Freire, Lee and Symons achieved these manipulations by employing a single male face as their stimulus and moving the eyes (up, down, in or out) and the mouth (up or down) to produce 8 resultant configural faces; to produce the featural stimuli the eyes and mouth of the original face were replaced with features from 7 other faces to create the 8 featural stimuli. In the first experiment a very strong inversion effect was evident for the configural faces; participants were much more accurate at identifying upright configurally altered faces than inverted ones. The task that was employed was an old-new matching task, where participants saw the target face at study and then identified which was the target face from a pair consisting of the target and a distracter. The second experiment explored the inversion effect with the featural faces and no such effect occurred. However, it must be pointed out that the design employed for all of the experiments was between subjects, so participants either took part in the upright condition or the inverted. No account was given for whether this might have impacted upon the result, but it is possible that it might have, for example, individual participant differences may have been a confound in the study (see the review of McKelvie, 1995, below). These authors propose that this is a more accurate way to assess the inversion effect as the usual confound of differing configural and featural information between stimuli has been removed; however, as noted above there are problems associated with feature swap studies. Whilst the authors did try to control for this aspect of the study by conducting rating tasks where participants rated the grotesqueness, distinctiveness and familiarity of the stimuli to ensure these factors would not affect the results, it is still possible that participants were aware of these stimuli being different due to the featural change and this is what eliminated the inversion effect.

Evidence drawn from research on the facial inversion effect therefore suggests that faces are processed configurally when upright, but as this processing mode is disrupted by inversion, featural processing occurs with faces presented in an upside down orientation.

6.1.2 Inversion and Expressions

The inversion effect has been shown to be extremely robust with facial identity and consistently produces reliable results; the manipulation has therefore been extended to facial expression perception. There is a problem encountered with the facial inversion effect for facial expressions however, and that is the inconsistent results reported by researchers. The results are not inconsistent in the fact that some studies find an inversion effect with expressions and some do not, rather that differences are found for individual emotions.

McKelvie (1995) investigated the inversion effect for facial expressions of emotion by employing all six (anger, disgust, fear, happiness, sadness and surprise) of the basic facial expressions as outlined by Ekman and Friesen (1976) as well as neutral expressions. In this investigation participants were required to identify the emotion being portrayed by an actor in a forced choice paradigm. The responses were recorded onto pre-prepared response sheets, which required participants to look away from the screen to circle the response. The first experiment was a between subjects design and an inversion effect for all expressions except happiness was found. Happiness was identified at near ceiling level in both the upright and inverted conditions. The second experiment was designed to address the potential problem of employing a between subjects design, and therefore was a repeated measures study. McKelvie suggested that the inversion effect may have been due to unaccounted for differences between the two participant groups, which is a perfectly fair assumption and one that is addressed in nearly every other inversion study by employing a repeated measures design so that any difference is due to the effect of inversion and not participant differences. The procedure remained the same for the second study and it revealed an inversion effect for anger, disgust, fear and sadness; however, no significant effect was found for happiness, surprise or neutral. McKelvie (1995) suggested that the expression of happiness is most probably a featural expression where the upturned mouth can still be identified on an inverted face and a similar explanation was also suggested for surprise and its wide open eyes. The author also proposed that the expressions where a consistent inversion effect was found (anger, disgust, fear and sadness) were more based on configural processing (particularly sadness and anger which had been identified as neutral when inverted), which is disrupted by inversion and therefore causes the detriment in recognition. The common confusions between expressions of surprise and fear and vice versa, and disgust confused with anger and vice versa were also found in both upright and inverted faces, suggesting that components can still be identified in inverted faces, even when recognition of the emotion is highly deteriorated.

Employing a signal detection procedure Prkachin (2003) examined participants' ability to recognise and label the six basic facial expressions of emotion (Ekman and Friesen, 1976) in a forced choice procedure. Prkachin asked participants to identify the facial expression being presented on a face and measured the number of hits and false alarms participants made. A hit was defined as the participant applying the correct label for a facial expression (e.g. pressing happy for a happy expression), whilst a false alarm occurred when the wrong label was applied (e.g. pressing happy for a sad expression). Prkachin then calculated the proportion of hits and false alarms and in turn these were converted into A' (a measure of sensitivity). An inversion effect was reported for each of the basic facial expressions, where recognition of each expression was reliably reduced when presented in the inverted orientation. Further to this inversion effect Prkachin also found that sensitivity to the emotions when upright correlated with the impact of inversion of the emotions. Participants were more sensitive to happiness, sadness and surprise with upright faces and these emotions were less disrupted by inversion; compared to anger, disgust and fear which were less well recognised when upright but had a larger effect of inversion. The author suggests that this is possibly indicative of a quantitative change in the processing of upright compared to inverted faces, rather than the qualitative one found with identity. Participants were simply finding it more difficult to identify these emotions when inverted, and the effect was more pronounced when the expressions were harder to identify when upright in the first place; rather than the processing strategy changing with inversion. In the second experiment reported, a different task was employed and rather than an identification (forced choice labelling) task, a detection task where participants were required to say yes when they saw a target expression is utilised. This experiment was therefore a between subjects investigation of detection of expressions as participants only responded to one of the expressions as their target. Again an inversion effect for each expression was found. However a different pattern of results emerged, whilst happiness and surprise were detected easily again when upright as was disgust, sadness was intermediate, but anger and fear remained harder to detect. When inverted, disruption was again high for the harder to detect emotions of anger and fear, whilst a small effect was found for the easier to detect emotions of happiness, surprise and disgust. Again, Prkachin suggests that these results are indicative of a quantitative, not qualitative, change in processing.

Whilst both Prkachin (2003) and McKelvie (1995) did essentially the same experiment, there were methodological differences. The identification study reported by Prkachin was conducted to extend upon the research of McKelvie, with subtle differences. Whilst McKelvie (1995) had allowed participants 15 seconds to respond to the facial expressions, Prkachin (2003) imposed a 1 second time limit on responses. It is possible that this timing change could have impacted upon the results as participants in McKelvie's study could have employed a different perceptual strategy with the inverted faces (such as mental rotation) which would have been allowed with the longer time limit and could have caused the lack of inversion effect with happiness, surprise and neutral that he discovered. The rigid time limit imposed by Prkachin would have excluded such a strategy from being employed.

Other authors have also reported inversion effects for certain facial expressions. Bartlett and Searcy (1993) were interested in whether the perception of expression is lost with inversion. They therefore considered neutral, happy and 'grotesque' inverted expressions (again, as already discussed, raising the problem of only including a select number of expressions with no justification for the decision). In the first study Bartlett and Searcy (1993) produced grotesque faces by manipulated smiling faces in one of three ways: 1) thatcherising the faces (inverting the eyes and mouth in an otherwise unmanipulated face), 2) lowering the mouth and moving the eyes up and closer together 3) moving the mouth up and the eyes down and eyes moved further apart. They also included, as stated above, neutral, smiling and posed grotesque facial expressions. The authors then tested for an inversion effect by asking participants to rate the grotesqueness of each face on a 7 point scale. They reasoned that if inversion does disrupt the ability to encode facial expressions, then there would be a reduction in the rated grotesqueness of the posed grotesque expressions as well as the thatcherised faces. Bartlett and Searcy (1993) did not find inversion effects for any of the three expressions-i.e. the facial expressions (without manipulations applied) were not judged as less grotesque when inverted. Therefore, suggesting that even when inverted, facial expressions can still be encoded. Inverting the manipulated versions of the faces did produce an inversion effect, however, with these faces being judged as significantly less grotesque when presented upside down compared to upright.

However, there are some methodological questions regarding the Bartlett and Searcy studies. Firstly, they claimed to have used ‘posed grotesque’ expression faces, but in actual fact the exemplar they provide in the paper is a fear expression face from the Ekman and Friesen (1976) set (female 4). Whilst this is not in itself a major issue, as fear is one of the basic expressions, it does mean that the final results presented by the authors have to be considered in different terms. Secondly, the authors do not use a traditional inversion effect measure i.e. reduction of reaction time to inverted faces or reduction in recognition; rather they look at grotesqueness ratings and same-different and similarity ratings. In their first experiment, Bartlett & Searcy found that inversion increased the grotesque ratings for happy, neutral and grotesque (fear face) and this was taken as evidence that inversion did not disrupt expression encoding, for if it had the grotesque ratings for grotesque (fear) faces would have reduced due to participants not being able to decode this expression. However, the fact that the expression was not actually representing grotesqueness means that this claim should be questioned at least. Why would a fear face expect to be seen as less grotesque when inverted than when upright, if it does not intrinsically show grotesqueness? Similarly the same question arises for the other two expressions of neutral and happy. Also, McKelvie (1995) and Prkachin (2003) found a positive inversion effect for fear faces (i.e. reduced recognition), thus questioning why the same was not found in the Bartlett and Searcy (1993) study. McKelvie (1995) acknowledged this discrepancy and suggested that Bartlett & Searcy's 'grotesque' faces could possibly have been construed as a mixture of fear and surprise and therefore when they were inverted, the confusion between surprise and fear would still have been evident and thus produced a null inversion effect. However, Bartlett and Searcy (1993) did not ask participants to recognise the expression or to label them, so there is no way of knowing which expression the participants saw the 'grotesque' faces as.

White (1999) used drawings of faces as stimuli and used neutral, sad, angry and happy expressions. These expressions were created by manipulating the shape of eyebrows and mouths; thus a problem is immediately apparent, that of ecological validity. Line drawings are not comparable to pictures of real faces and when expressions have been created through just the shape of eyebrows and mouth, the question of whether these resulting stimuli are representative of the expressions has to be asked. Leder (1996) concluded that line drawings of faces reduce configural processing and render participants less sensitive to configural manipulations compared to when the stimuli are presented as photographs. Also the task was a speeded 'go/no go' one where participants were required to press one button when a face had eyebrows and mouth, and a different button when these features were absent-so it was not an expression recognition task or a detection task. Overall White found that reaction times were longer when expressions were presented inverted than upright. Whilst White proposes in the paper that one of the important criticisms regarding facial expression research is the lack of consideration of each expression and that it is important to

> "use different (and ecologically valid) expressions and to report results for the different expressions" (White, 1999, p372),

he fails to then justify this criticism by addressing it in his own study. There is no consideration of the inversion effect on each individual expression, reporting instead the overall inversion effect and presenting the mean reaction times for each expression averaged over orientation. This is a common theme throughout facial expression research. However, another important consideration with the White (1999) study is whether participants were actually distinguishing between the expressions or not: as this was never investigated, it is hard to evaluate the inversion effects found for these ‘expressions’.

Line drawings were also the stimuli employed by Fallshore and Bartholow (2003). The line drawings depicted the six basic facial expressions of emotion and contained 4 facial features (eyebrows, eyes, nose and mouth); the stimuli had previously been created for a developmental study by MacDonald, Kirkpatrick and Sullivan (1996). An inversion effect of reduced recognition accuracy was found for the expressions of anger, fear, happiness and sadness, but not for surprise and disgust. These results therefore provide evidence for no inversion effect for another expression-that of disgust. It is possible that the results obtained were due to a trait of the stimuli, with the authors themselves proposing that the surprise face may have been too simplistic and disgust too ambiguous, but as yet no investigation of the stimuli has been conducted.

It is therefore, in light of the above research, plausible that the differences reported for facial expressions and inversion are due to differences in methodology and differences in stimuli. As can be seen in Table 1 (page 59 of the first experimental chapter) there is very little agreement between authors regarding which expressions show an inversion effect.

6.1.3 The Thatcher Illusion

The Thatcher illusion was introduced in 1980 by Peter Thompson and fast became an important manipulation in face processing research. In the illusion the eyes and mouth of a face are inverted in an otherwise unaltered face and this manipulation creates a face which is perceived as being strange or grotesque. A further facet to the illusions is evident when the Thatcherised face is globally inverted, as the perception of strangeness or grotesqueness disappears (Thompson, 1980; Bartlett & Searcy, 1993). This dramatic change in the appearance of the face has been taken as evidence for a qualitative shift in processing strategy for upright and inverted faces (Bartlett & Searcy, 1993; Lewis & Johnston, 1997; Murray, Yong & Rhodes, 2000). The Thatcher illusion can be seen in Figure 1: the top left picture depicts a normal happy face, whilst the picture below it shows the same face inverted; the pictures to the right are the Thatcherised versions-the top right picture is an upright Thatcher face, whilst the one below is the inverted image. The top right picture will look slightly strange, and rather different from its normal counterpart next to it. However, the inverted pictures will look remarkably similar and the perception of strangeness should have disappeared in the inverted Thatcher face. This is an important element to the Thatcher illusion-an inverted Thatcher face looks very similar to a normal inverted face, whilst the upright images look very different (Bartlett & Searcy, 1993;

Leder, Candrian, Huber & Bruce, 2001; Searcy & Bartlett, 1996). The Thatcher illusion and the facial inversion effect are therefore closely connected.

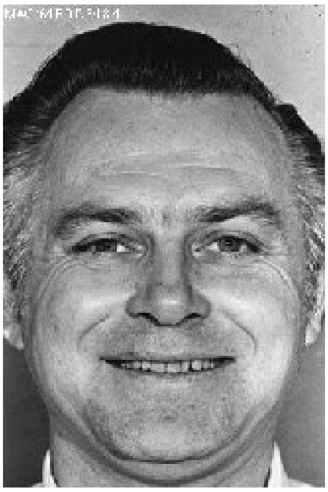

Figure 1a

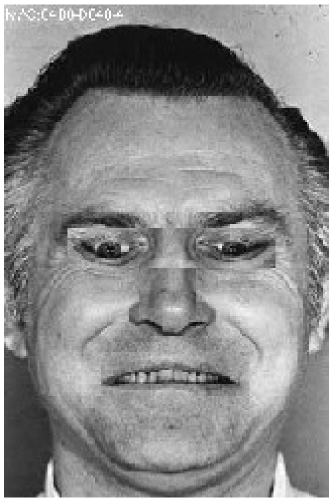

Figure 1b

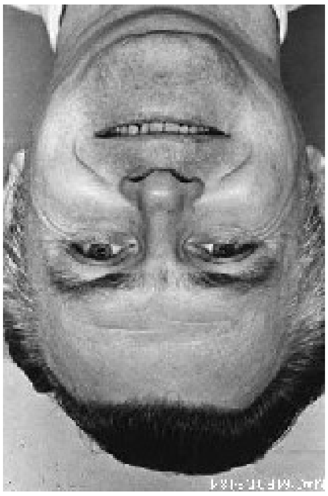

Figure 1c

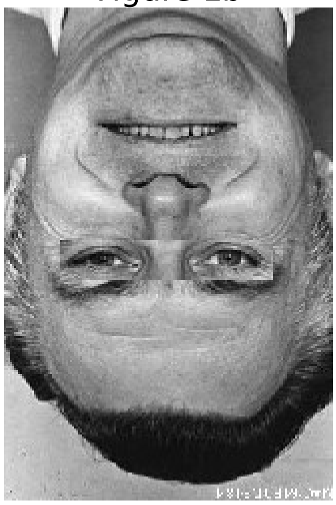

Figure 1d

Figure 1. Examples of experimental stimuli, 1a = upright unmanipulated face, 1b = upright Thatcher face, 1c = inverted unmanipulated face 1d = inverted Thatcher face (taken from Ekman and Friesen, 1976)

The way that a Thatcher face is distorted is a configural rather than a featural manipulation (Bartlett and Searcy, 1993; Lewis and Johnston, 1997) as the features remain unaltered, just locally inverted. However, the configuration of the face is changed, there is no longer the first order relational information of two upright eyes, above an upright nose, above an upright mouth, and the second order relational information has also been altered. The distance between the top of the mouth and the bottom of the nose, the interrelationship between the top of the mouth and the eyes etc have all been manipulated. Added to the change in internal feature configuration is also the change in the configuration of the features with the outer features of the face, for example, the relationship between the mouth and the chin, the eyes and the hairline etc. When the upright Thatcher face is perceived these configural changes are immediately obvious due to the configural processing strategy employed with upright faces; however, when the face is then globally inverted and featural processing becomes dominant, the configural manipulations are no longer as easily and obviously perceived. Featural processing does not detect the strange configuration, indeed, as can be seen in Figure 1d (inverted Thatcher face) the features of an inverted Thatcherised face also remain in their normal 'upright' orientation and may therefore be easier to process and recognise (this assertion is addressed in the first experiment in this thesis). Due to the disruption of configural information in a Thatcherised face, the illusion can be employed to examine configural processing of faces and the impact of inversion upon configural processing and manipulations.

Studies on the rated grotesqueness of the Thatcher illusion have supported the conclusion that an upright Thatcher (and normal) face is processed configurally, and this mode of processing is disrupted by inversion. Bartlett & Searcy (1993)found that participants rated

Thatcher and spatially distorted faces (eyes and mouth moved up/down in the face context) as less grotesque when inverted than upright; however, the same inversion effect was not found for posed grotesque, normal smiling or neutral facial expressions. Therefore suggesting that one of the original hypotheses about the Thatcher illusion-that it is seen as having a grotesque appearance due to a change in facial expression and that this perception is lost in an inverted face as expressions cannot be encoded when upside down (Yin, 1970) - is not valid. Expressions were encoded in the inverted face, or at least their aesthetic appearance of grotesqueness was encoded in the inverted orientation. A similarity ratings study was also conducted by Bartlett & Searcy (1993) who asked participants to rate the similarity of either Thatcher faces, spatially distorted faces or posed expressions to normal smiling faces. These authors also included the manipulation of orientation, with stimuli being presented both upright and inverted. This task revealed that the two types of configural distortion (Thatcherisation and spatial distortion) also behaved in the same way in the matching task, where both Thatcherised and spatially distorted faces were judged as more similar to normal smiling faces when they were inverted than when they were upright. Again, this did not occur for the posed expressions, adding to their conclusion regarding the encoding of facial expressions in inverted faces. The authors therefore suggest that the processing of upright faces is primarily wholistic (their term for configural) although they acknowledge that componential or featural processing can also take place with upright faces, and that this mode of processing is disrupted with inverted faces. In a follow up investigation Searcy and Bartlett (1996) employed the same tasks again, but this time included a component distortion condition e.g. blackened teeth or blurred pupils. It was found that these component distortions behaved very similarly to the posed expressions in the original 1993 studies, with no inversion effect found for either grotesqueness ratings or accuracy in the same-different comparison task. However, the response latencies in the same-different task for component distortions did increase with inversion, suggesting that inversion did impact upon the encoding of *these* components. It is possible however that inversion slows processing down with all inverted stimuli, as the results of the other two tasks over 3 different experiments suggest that there is no effect of inversion on component changes. Therefore still supporting the view that upright faces are processed configurally and inverted are processed featurally.

Murray, Yong and Rhodes (2000) also employed a grotesqueness rating task with Thatcherised, spatially distorted, normal and componentially distorted faces (the eyes of the faces had been whitened or the teeth blackened). The grotesqueness rating for normal and component-distortion faces gradually increased as the faces were rotated from upright to the inverted, but for Thatcherised and spatially distorted faces this trend was reversed. Again, the conclusion is that there is a qualitative difference in the processing strategy for upright and inverted faces, with upright being processed configurally and inverted featurally. However, an interesting result of the Murray et al. (2000)

study was that whilst the grotesqueness ratings for spatially-distorted faces (eyes and mouth moved up/down) did reduce with rotation from upright, after approximately 90 degrees from upright, the ratings were surprisingly similar to those for component distortion faces. These authors suggest that if the assumption that inverted faces are processed featurally is accepted then these results could reflect a component-orientation effect; as the components of the normal, component distortion and spatially distorted faces all remain in the same orientation as each other during inversion (i.e. upright in the upright face and inverted in the inverted face), whereas Thatcherised components change orientation with inversion (they are inverted in an upright face and upright in an inverted face). This echoes the suggestion made above that component or featural information in a Thatcher face may be more easily recognised in the inverted version as the normal features that they are (the Thatcher faces were created from normal smiling faces) and thus the perception of grotesqueness is lost in favour of the pleasant appearance of the features (again, this is addressed by studies in the current thesis). It is an important issue to raise regarding the Thatcher illusion that all examples of Thatcher faces employed in research so far have been manipulated versions of smiling/happy faces or neutral faces, but primarily of the happy expression (Bartlett & Searcy, 1993; Leder et al, 2001; Lewis & Johnston, 1997; Murray et al, 2000; Searcy & Bartlett, 1996; Thompson, 1980). This reliance upon a pleasant face before manipulation could therefore impact upon the Thatcher illusion itself, so the present

Thatcher illusion study employs all of the six basic facial expressions of emotion to investigate the impact of expression upon the illusion.

Parks, Coss and Coss (1985) also found that the context in which a mouth feature is seen will affect the rated pleasantness of that mouth. Whilst not directly investigating configural processing these authors found that when a mouth was placed either above, below, near to or far away from a pair of eyes, the judged pleasantness of that mouth was affected by the position of the eyes. Whilst an inverted mouth presented on its own was seen as a gruesome, biting expression, if eyes were placed below it this perception changed to one of pleasantness as participants saw the now inverted mouth as part of an inverted smiling face. This occurred even though participants were instructed to ignore the eyes. This therefore confers with the suggestion that the implied orientation of a feature within a face context will impact upon its aesthetic perception.

In 1993, Rhodes et al. extended the use of the Thatcher illusion to studies of old/new face recognition rather than just to grotesqueness ratings. The configural manipulation of faces was again exploited in this study where participants had to indicate whether one face in a pair was an 'old' face i.e. one that had been seen before or whether they were both 'new' faces i.e. unseen before. This study revealed large inversion decrements of reduced accuracy when one of the faces was a Thatcher face or a spatially distorted face. However, when isolated feature changes were presented (presence/absence of glasses) accuracy was not significantly reduced with inversion. This study suggests that as well as a change in processing at the perceptual encoding stage of processing (i.e. grotesqueness ratings) the distinction continues with memory tasks. As well as problems with this study which have been noted above (such as the feature swap manipulation being automatically processed configurally by participants and the addition of non-facial items such as glasses causing the faces to become more distinct) the faces employed by Rhodes et al. also displayed varying facial expressions (these are not identified in the study) which could also have impacted upon the results, with some expressions easier to identify in inverted orientations than others (see above studies on facial expressions and inversion). Orientation was also a between subjects variable and therefore participant differences could account for some of the changes found with different stimuli; however, this factor was corrected for in consequent studies and the results remained the same.

The results of studies with the Thatcher illusion (Thompson, 1980) suggest that there is a qualitative difference between the processing of upright and inverted faces. Thatcherised faces are consistently perceived as more grotesque when upright than inverted and are judged as more similar to normal unmanipulated faces when they are inverted compared to when upright (Bartlett & Searcy, 1993; Murray et al, 2000; Leder, et al, 2001). Rhodes et al. (1993) also provided evidence that this change in processing is evident at the perceptual encoding stage and is not just elicited by memory tasks. The results taken together suggest that the Thatcher illusion is a good way of investigating the impact of configural processing upon faces. Yet, whilst the perception of the grotesqueness of Thatcherised faces has been the focus of much research, the ability to recognise facial expressions in such faces has only been investigated once to date (Muskat and Sjoberg, 1997). However, Muskat and Sjoberg's study was only interested in whether componential information is disrupted by inversion and not the recognition of expressions per se.

Muskat & Sjoberg (1997) employed the Thatcher illusion and the facial inversion effect in order to investigate componential processing (featural) in facial expressions of emotion. By comparing participants' correct recognition of the six Ekman and Friesen (1976) basic facial expressions in normal upright, normal inverted and Thatcher inverted faces the authors were able to assess the use of normal component information. An inversion effect with unmanipulated faces was found for anger, sadness and disgust, but not for the other expressions (happiness, fear and surprise). However, the authors argued that if the inversion effect impaired component information, then in an inverted Thatcher face there should be no inversion effect as the component information remains in the normal upright position. The results of this comparison revealed that there was no significant difference between the normal inverted and Thatcher inverted correct recognition scores. Therefore the authors concluded that component information did not facilitate recognition in an inverted Thatcher face and that it is possible that this information is not used to process inverted faces. However, it should be pointed out that this conclusion is in conflict with research suggesting that component information is the processing strategy employed with inverted faces. As already noted above, Muskat and Sjoberg did not report results for each individual expression as the aim of their study was not to investigate emotion recognition but rather to examine the use of component information in inverted faces. Therefore there are numerous questions which remain unanswered from this research, for example, was there a classic inversion effect with inverted Thatcher faces i.e. was correct recognition reduced with inverted Thatcher faces compared to upright Thatcher faces (where the same transformation has occurred); were the reaction scores compared expression by expression or just overall; was there a significant difference between upright normal and inverted Thatcher faces (where componential information is the same)? The study is also not fully explained as no detail is given regarding participants, stimuli, procedure or analysis method.

Further to this study on facial expressions and Thatcherisation, Leder et al. (2001) have employed the Thatcher illusion to assess the impact of context upon configural processing. These authors argued that the difference between an upright unmanipulated face and an inverted Thatcherised face is the context of the face that the components are in. Their comparison of participant’s ability to indicate the larger interocular distance between the eyes of two faces revealed that the inversion effect disappears when the features of the inverted face remain the same as in an upright face (i.e. in an upright orientation, as in the inverted Thatcher face). Participants did not show a decrease in sensitivity to process the interocular distance in the inverted Thatcher face compared to in a normal upright face. The authors argue that this result indicated that what is necessary for an inversion effect is inversion of the facial features, rather than just inversion of the face context. These researchers therefore propose that comparison of upright unmanipulated faces and inverted Thatcher faces can reveal whether there is a classic inversion effect for the processing of Thatcher faces. This comparison is therefore also considered by the Thatcher study in this thesis. However, it is also acknowledged that the task required by the Leder et al. study could be construed as a featural or serial processing task, where participants are aware of the information they are to assess; therefore configural processing is not employed. Leder et al (2001) argue that this is not what occurs and that the interocular distance is a relational feature, but it is possible that participants were ‘primed’ to use featural information with such a specific task.

Whilst the possibility exists that the Thatcher illusion could be an important manipulation to employ with facial expression research due to the effects already found with the manipulation, the potential of the illusion has not been exploited. The use of the Thatcher illusion to research the recognition of facial expressions has so far not been investigated, and therefore the impact of this configural manipulation has not been assessed.

6.1.4 The Composite Effect

As already mentioned above, one of the methods employed with inverted faces is that of composite faces. The composite effect for faces was first introduced by Francis Galton in 1878, where photographs had been constructed that were in fact a composite of a number of photographs all superimposed onto each other. Galton had proposed that by constructing these composites he could predict such things as a person's susceptibility to certain diseases (based on their physical appearance and their relatedness to composites of people with the disease in question) or criminality etc. This method did not prove successful for the uses which Galton had hoped; it did however provide a useful research tool.

The use of the composite effect for facial research has now been developed into a technique of splicing together two halves of different faces to form what is now known as a composite face (see Figure 2 for an example composite face). Young, Hellawell and Hay (1987) created face composites by combining two familiar (famous) face halves together, so that the resultant face consisted of the top half of one individual's face and the bottom half of another's. These researchers discovered that when these two halves were aligned to form a 'whole' facial configuration, participants were significantly slower to identify either half of the face compared to when the two halves were misaligned or the composite was inverted. In fact, reaction times were faster in the inverted condition compared to upright. This manipulation is taken as a direct example of the importance of configural processing in upright faces. When the composite face is aligned and upright, the visual system processes it as a whole face configuration (i.e. configurally); however, this new configuration does not match with the stored configuration for either face half, and therefore recognition times are increased. Once the face is misaligned or inverted, configural processing is disrupted and featural takes over, therefore the two face halves can be easily recognised due to the lack of interference from the new face configuration. The crucial aspect of the composite effect is that the facial features are the same in all conditions; therefore, when the reaction times differ for composites and non-composites (misaligned or inverted) this reveals that a different processing strategy is being employed for the two types of stimuli. Rhodes et al. (1993) suggest “This clever experiment offers the best support so far for the disproportionate effect of inversion on relational information” (p. 30).

Figure 2. A composite face comprising of two different identities both displaying the facial expression of anger.

The composite effect does not only hold for 'real' faces i.e. photographs of faces, it also occurs with unrealistic, schematic drawings of faces. Endo, Masame & Maruyama (1989) found that participants did show the composite effect with line drawn faces i.e. they were slower to recognise a composite face than a misaligned non composite. Thus demonstrating that the interference effect from the perceived facial configuration held even for unrealistic faces. The same authors replicated this result in 1990, where participants were substantially slower to identify part of a composite drawing compared to a misaligned non-composite. They also replicated the findings from Young, Hellawell and Hay (1987) with inverted composites. When the schematic drawings were rotated through 180 degrees participants showed no reaction time differences between composites and non-composites. However, Masame & Maruyama (1989) did not find the 'inversion advantage' that Young, Hellawell and Hay (1987) reported i.e. faster reaction times with inverted composites than upright composites; it is possible that this difference reflects the fact that in the Young et al. study the variable of orientation was a within subjects one, whilst in the Endo et al experiment it was between subjects. Endo et al. (1990) acknowledge that their subjects did not perform well in their training sessions with inverted faces, so it is possible that the difference was due to some uncontrollable difference between participant groups. It is also possible that these differences reflected the differences between the two types of stimuli used i.e. faces and drawings. In the drawings it is much harder to see that there are two ‘halves’ put together as there are no cues from context, tone or texture, unlike in a face. These two studies therefore show that the composite facial effect is a robust manipulation that can be applied to both real and schematic faces.

This composite effect has been extended to research facial expressions. For facial expression composites Calder et al. (2000b) used faces expressing emotion via facial expressions to form the composite stimuli. Using the top half of one expression and the bottom half of another, composites were created. By employing the same actress in the pictures the authors ensured that any effect that was observed was due to expression and not interference from different identities. This study yielded a composite effect for facial expressions i.e. longer latencies with composite faces than misaligned non-composites. This composite effect therefore provides further support for the hypothesis that facial expressions are processed configurally when upright, but this processing is interfered with due to inversion, therefore some other form of processing takes place. However, the authors also go on to suggest that unlike facial identity, the crucial aspect of configural processing with expressions could be first order configuration (i.e. the coarser configuration common to all faces of eyes above a nose above a mouth) rather than the fine-grained second order configuration that seems important for facial identity. This is the only study which employs the composite effect for expressions, and as will be discussed in the experimental chapter on the composite effect, the different expressions have not been fully exploited until now with the effect.

6.1.5 Filtration/Spatial Scale manipulation

Faces, like any other object or image, contain a spectrum of spatial information and the analysis of this spatial frequency spectrum forms an early stage of visual processing (Goffaux, Hault, Michel, Vuong & Rossion, 2005). The spectrum of frequencies could be considered as moving from high spatial frequencies to low spatial frequencies, with these two categories encoding different information. High spatial frequencies are associated with encoding the highly detailed parts of an image (for example, edges) whereas the low spatial frequencies encode more coarse information, relating to the larger, less well defined or detailed parts of an image. Morrison and Schyns (2001) go on to suggest that high spatial frequencies encode the fine detail information in a face, such as the shape of the eyes and mouth, the contours of the nose and even individual eyelashes; whereas, the low spatial frequencies encode the coarser information such as configuration (Sergent, 1986). It has also been suggested that the analysis of these different spatial frequencies occurs at different speeds, with the coarse lower spatial frequencies being filtered relatively quickly and the higher spatial frequencies taking longer to be processed (Morrison and Schyns, 2001).

It has been proposed that the spatial analysis of faces not only forms an important part of the processing of faces but could also therefore provide an important method of manipulation (Costen, Parker & Craw, 1994; Morrison & Schyns, 2001; Goffaux Gauthier & Rossion, 2003). Costen et al. (1994) removed the high spatial frequency information in face images by applying a blurring filter to them and found that this manipulation affected featural processing more than configural. These authors also found that it is an intermediate level of blur that causes this featural/configural distinction. At high and low levels of blur either not enough information is retained in a face for identification to be performed or no effect on processing occurs. However, within the range that does impact upon processing, progressive addition of blur does mask featural information both earlier and more completely than configural processing. Sergent (1986) also found that featural information was impacted at an early stage and that facial identification could still be achieved with coarse configural information only. A face with a blur filter applied to it can be seen in Figure 3.

Figure 3. Picture of an actress portraying an angry facial expression with a blur filter applied to the photograph (taken from Ekman and Friesen, 1976)

Collishaw and Hole (2000) employed a spatial filtering technique to investigate the recognition of faces. Applying a certain blur filter to facial images the authors affected the featural information in the face whilst leaving the configural information largely unaffected. As well as investigating this featural manipulation, configural effects were also applied (inversion and scrambling). It was found that participants' accuracy at identifying faces was significantly reduced by blurring, inversion and scrambling. Further, additive effects were found in conditions where both featural and configural information was disrupted (blurred & inverted, and blurred & scrambled). In these conditions recognition accuracy was reduced to chance (revealing that both processing strategies were disrupted). In the blur only condition recognition was significantly reduced, but was still above chance level, as although featural processing had been precluded, configural processing remained available. Likewise in the inverted and scrambled conditions recognition was again reduced but remained above chance due to the faces being processed featurally. This study therefore lends support to the idea that blurring faces precludes one type of processing (featural) whilst inversion and scrambling affect another form of processing (configural).

Goffaux, Hault, Michel, Vuong and Rossion (2004) investigated the impacts of restricting the available spatial frequencies in faces which had had featural and configural manipulations applied to them. These authors created configural faces by changing the interocular distance or moving the height of the eyes; and featural faces were created by replacing the eyes in one face with those of another. Then a combination of these manipulations was applied to create configural + featural change faces. These faces were then transformed by applying Gaussian filters to them, retaining either low spatial frequencies or high spatial frequencies. The participants' task was to match a target face to two simultaneously presented faces. It was found that faces which differed only in featural terms were matched with more efficiency in the high spatial frequency faces than in the low spatial frequency faces where configural information was retained. Conversely, participants were more efficient with faces containing low spatial frequencies when configural changes had been made. The Goffaux et al. (2004) study therefore provides evidence that the processing of configural and featural properties of a face is supported by low and high spatial frequencies respectively. However, Goffaux et al. do admit that their high spatial frequency condition, whilst disrupting low spatial frequency information and leaving featural information intact, does still allow configural information within the face. Whilst the shape and structure of individual features can still be seen within a high spatial frequency face, so can the relative relations between these features, therefore configural processing could still take place. With the low spatial frequency images, featural information was disrupted to a higher degree, therefore disrupting featural information and processing much more.

So far however, the spatial analysis of facial expressions has been primarily investigated by neural studies, looking at the ERP related potentials and the neural responses to faces displaying high and low spatial frequencies. Results from these studies have revealed that different areas of the brain do in fact respond to different spatial frequencies with facial expressions of emotion. Vuilleumier, Armony, Driver and Raymond (2003) found that the fusiform gyrus was more responsive to emotional facial expressions containing all spatial frequencies or only high spatial frequencies rather than low, but that the amygdala was more responsive to intact fearful faces or fearful faces containing only low spatial frequencies rather than high. This would suggest that spatial frequency information is an important feature of facial expression processing.

So far only two studies have attempted to investigate the effects of blurring on facial expressions. Endo, Kirita and Abe (1995) employed the facial expressions of happy and sad and asked participants to decide between whether a face was either happy/sad or neutral. Endo et al. found that participants could accurately discriminate between happy and neutral expressions unless the level of blur applied was quite high, whereas discrimination between sad and neutral expressions was impacted upon by relatively low levels of blur, and discrimination accuracy continued to decline for sadness as the level of blur increased. Endo et al. also investigated the recognition of happy and sad expressions after a blur filter had been applied to them. Happy faces which had been blurred were still recognised as quickly as their unmanipulated versions; however, the reaction time for participants to recognise sad facial expressions was reduced when blur was applied. These authors conclude that the facial expression of happiness can be recognised when only low spatial frequencies are available, but sadness requires the presence of high spatial frequencies for recognition. It was concluded that the expression of happiness is recognised holistically whereas sadness is more analytically recognised. Whilst this study makes an important contribution to research upon facial expressions, it does not consider the potential impact of blur upon expressions other than happiness and sadness; and Endo et al. admit that there is often a happy face advantage which could have impacted upon using this expression. Therefore the impact of blur and noise on the recognition and processing of facial expressions still requires investigation, and particularly to include more of the basic facial expressions of emotion than were considered by Endo et al. (1995).

In a recent study White and Li (2006) explored the impact of blurring and pixellating on facial expressions of emotion. These authors employed a matching paradigm to investigate the ability to match both facial identity and expression in three conditions-blurring, pixellating and unmanipulated. It was found that expression matches elicited longer latencies than identity matches and that expression matches were more impacted by the manipulations than were the identity matches. It was also found that expressions were equally as affected by pixellating and blurring, with no significant differences between these two manipulations on the ability to match expressions.

One criticism of spatial scale studies with faces is that they often employ a matching task, or a discrimination task, and these tasks do not reflect natural face processing. Therefore these techniques may not reveal which spatial frequencies are important for different processing methods for facial or expression identification. A further criticism is the use of the same faces for the practice trials or the familiarisation part of studies and for the experimental sessions. This problem may pose the risk that participants are actually showing effects of spatial scale manipulations in response to picture recognition and not face recognition (Morrison and Schyns, 2001). However, it still remains that as of yet, a spatial scale manipulation is the only featural manipulation to be employed with faces and facial expressions that does not suffer from the confounding effects of also inherently changing configural information or preclude/discourage the use of configural processing. Other featural manipulations, such as feature exchange (putting the features of one face into those of another) automatically cause changes in the face configuration; whereas featural manipulations such as blackening the teeth cause configural processing to be discouraged. Changing the available spatial information within a face does not automatically change the configural information available or preclude configural processing. This is therefore invaluable in investigating the processing of facial expressions as the majority of research employs configural manipulations, and conclusions about featural information and processing have largely been drawn from null effects with configural manipulations. Altering spatial scale information allows a direct comparison of facial expressions with and without a featural manipulation applied.

6.1.6 Summary

By employing the four manipulations reviewed above (inversion, Thatcherisation, composite faces and spatial scale manipulation) the current research aims to investigate the influence of configural and featural information and processing upon the recognition of facial expressions of emotion. The use of all four manipulations upon the same set of stimuli (Ekman and Friesen pictures of facial affect), using the same facial expressions (anger, disgust, fear, happiness, sadness and surprise) with a forced choice methodology, will hopefully go some way to addressing the question posed in the introduction to this research 'what is the mode of processing for facial expressions, is it configural, featural, or a combination of both'.

7 A SWITCH IN PROCESSING?

Although there is still disagreement in the literature regarding how facial expressions of emotion are processed and recognised with regard to configural and featural information, there has been an accompanying increasing trend to discover if there is a switch between these two modes of processing. Largely based on research on facial identity the consensus is that there is a disruption in the processing of configural information/processing when a face is inverted. This means that the perception of inverted faces is reliant upon featural information, with many researchers suggesting that features are non-orientation specific (Searcy and Bartlett, 1996; Farah et al., 1998; Tanaka and Sengco, 1997; Freire et al., 2000). In recent years research has begun to look at whether, as faces are rotated from upright, there is a switch in the processing mode employed or a gradual decline in processing ability.

Whilst research has been quite prolific in this area, the results have been somewhat contradictory regarding a processing switch or a general decline. The Thatcher illusion (Thompson, 1980) has been employed as one way to test the effects of rotation upon face processing as these faces change from being perceived as grotesque or unpleasant in the upright orientation to normal or pleasant when inverted. It is suggested that the disruption in configural processing that occurs in inverted faces results in the configural changes which occur due to feature inversion going unidentified. Sturzel and Spillmann (2000) employed the illusion in their investigation of the effects of rotation by asking participants to indicate when they perceived a Thatcherised face changing from grotesque to pleasant. The method employed for this study was to put pictures of the stimuli onto a free spinning disc that was then rotated through 180 degrees and participants indicated when they perceived the change to have occurred. The results indicated a sharp discontinuity between the angles of 94 degrees and 100 degrees (from upright), which was taken as evidence of a qualitative change in the type of processing employed (from configural to featural). Sjoberg and Windes (1992) had also previously found an increase in reaction time to make a decision on whether a face had been Thatcherised or not as the angle of rotation was increased from zero; and also reported that the greatest increase was between the angles of 60 degrees and 120 degrees. However, these authors presented faces (mac-a-mug, which are acknowledged as being a little unrealistic) at different angles of rotation varying in steps of 60 degrees and therefore could only state that somewhere in a 60 degree segment, reaction times increased as participants tried to decide whether an unrealistic face was thatcherised or not. Whilst the study indicated that a change in processing was occurring between these angles, the margin of 60 degrees could also have allowed for a quantitative decline in the ability to process the faces using configural information, and not necessarily reflect a qualitative change.

In 2000 Murray, Yong and Rhodes employed normal, unaltered faces, Thatcher faces (which are composed of configural changes) and component distortion faces (eyes were whitened and teeth blackened) and asked participants to rate the bizarreness of faces as they were rotated from upright. A linear increase in the bizarreness rating for both normal and component distortion faces was found as the faces were rotated from upright. However, bizarreness ratings for the Thatcherised versions decreased with rotation from upright. Further, a discontinuity was found for bizarreness ratings of Thatcher faces between the angles of 90 degrees and 120 degrees. However, no such discontinuity was found for faces with component distortions applied to them. This result further supports the suggestion that configural processing is disrupted by inversion and that ‘a switch’ from configural processing occurs. The fact that no discontinuity occurred for the component distortions suggests that featural changes are not as affected by the disruption to configural processing as configural changes are. However, the linear increase in rated bizarreness of the featural changes does suggest that featural processing is affected by rotation, so that as features become inverted they are seen as more bizarre. Murray et al. conclude that there *is* a qualitative difference in processing strategies for upright and inverted faces.

However, as already acknowledged, some research has failed to find a qualitative ‘switch’ in processing at any given angle, but rather found a quantitative decline in ability to process configural information. Lewis (2001) reported such a gradual loss of configural information as a face is rotated from upright. Employing the Thatcher illusion Lewis rotated faces in steps of 10 degrees instead of the 60 degrees employed by Sjoberg and Windes (1992), which could have impacted upon the results, as it was a more sensitive measure. Lewis proposes that instead of the traditional idea of a dichotomy between configural and featural processing strategies, they should be thought of as lying on a continuum from very configural to very featural. Collishaw and Hole (2002) also reported a linear relationship between angle of rotation and recognition of familiar faces; the further from upright a face was rotated, the harder it became to recognise that face. Lewis and

Glenister (2003) extended the research to include individual facial features as well as whole faces and employed only two angles of rotation: 90 and 180 degrees. It was found that for whole faces recognition decreased with the angle of rotation; however, with isolated features recognition was poorest at 90 degrees, indicating that inversion does not have such a detrimental effect on feature processing as it does on configural processing.

As yet there is no consensus regarding whether the inversion effect reflects a decline in processing ability or a change in the processing method employed. There is also some evidence for a lack of orientation specificity for featural information. However, this research has yet to be extended into the field of facial expression perception.

8 TYPES OF CONFIGURATION

As well as the research on both facial identity and facial expressions aiming to ascertain which of the two processing strategies are primarily used to process faces and expressions, there is also interest in whether the type of configural information can be important.

There is a substantial literature which suggests that facial identity processing is very different from basic-level object processing. Evidence for this difference has been drawn from various areas, including the large inversion effect found with faces compared to objects (Carey & Diamond, 1977; Yin, 1969); the fact that faces are far harder to identify in negative compared to objects (Bruce & Langton, 1994); and the use of different coding representations for facial and object identification (Cooper & Wojan, 2000). There is also neuropsychological evidence for this difference, including clusters of cells which become active to faces but not other objects (Sergent, Ohta & MacDonald, 1992); neurological impairments which affect identity but not object recognition and vice versa (Farah, 1994) and different hemispheric specialisation for the two processes (Young, Bion & Ellis, 1980; Schmuller & Goodman, 1980; Biederman & Cooper, 1991).

Further to this distinction, recent research also suggests that facial expression processing is more akin to basic-level object processing (Cooper & Wojan, 2000) which, as noted above, has been found to be very different from facial identity processing. Thus there is a growing body of research that proposes that the processing of facial identities and facial expressions may in fact be dissociable.

The possibility of a dissociation between identity and expression was introduced in the Bruce and Young (1986) functional model, which suggested that at the structural encoding stage the processing of these two types of information is divided. A large amount of credible evidence for this division comes from the neuropsychological literature, particularly that concerning prosopagnosia. Prosopagnosia is a condition whereby patients cannot recognise familiar facial identities, which can include famous faces as well as friends and family (Hécaen and Angelergues, 1962). However, people with the condition can still recognise and process facial expressions of emotion. Patients have also been reported who have suffered amygdaloid lesions and have problems with facial expression processing but not with facial identity (Etcoff, 1984; Tranel, Damasio & Damasio, 1988). Therefore research into this possible distinction between identity and expression has started to emerge.

It has been proposed that recognition of facial identity is reliant upon second order information whilst facial expressions (and objects) are more reliant upon first order or categorical relationships (Cooper & Wojan, 2000; White, 2000). The proposal that facial expressions are more reliant upon first order than second order relational information is also consistent with observations made by Ekman and Friesen (1975) regarding the display of facial expressions. They provided evidence that each of the six basic expressions are associated with common configurations of the features e.g. in happiness the eyebrows are flat, there are small wrinkles (known as crows-feet) at the corner of the eyes, there is no change in the nose, and the mouth is turned upward at the outer edges to produce a smile. Similar configurations can be recognised for all of the expressions, in surprise the eyebrows are high and curved upwards, the eyes are open wide, the nose is unaltered or nostrils can be slightly flared, and the mouth is also opened wide. Whilst the interrelationships between these individual ‘features’ of each expression would be considered second order configural information, the first order configuration would consist of the set pattern of the features within a face (for example, two happy eyebrows, above happy eyes, above a happy mouth).

In 2002 Murray White proposed that the difference between identity and expressions might be due to the processing of different types of information within a face and the different processing strategies employed. White employed an eye displacement technique where photographs of faces had either one eye or both eyes moved upwards into the forehead region. By moving only one eye in the face the first order configuration was disrupted as the configural order (2 *aligned* eyes, above a nose, above a mouth) was no longer available, however, the second order configuration was still largely unaffected as the unmoved eye still retained the distances and interrelationships within the face. The two eyes moved condition impacted on the second order configuration but not the first, as the featural order was still intact but the interrelationships were maximally affected. This manipulation was therefore used to maximally affect second order information (two eyes moved) or maximally disrupt first order information (one eye moved), thus providing a comparison of how these two types of information impact upon facial processing. White then compared participants' performance with these two manipulations on the tasks of facial identity matching and facial expression matching. It was found that facial expression matching was harder in the one eye moved condition than in the two eyes moved condition, with this pattern reversed for facial identity matching.

This supposition of facial expressions being reliant upon categorical information/relationships also concurs with the conclusion drawn by Calder et al. (2000b) that the composite effect for facial expressions occurs due to a disruption of the first order information in a face. Calder et al. (2000b) propose that each expression will be part of a cluster of expressions formed around a prototype and that these clusters will share a typical configuration with individual feature information also playing an important role.

Categorical or first order relations can be manipulated in two ways: scrambling the face and categorical displacement (as used by White). By scrambling a face the first order relations are disrupted if the positions of the eyes and mouth are interchanged, or if the nose moves into the eye region, with the mouth replacing the nose and the eyes moving to the mouth area. However, one inherent problem with scrambling is that the second order information is also disrupted within the face. With the categorical manipulation employed by White, the second order information is only minimally disrupted as only one eye is moved. The first order information is however maximally disturbed as the eyes are no longer aligned horizontally, so the typical face configuration is not available.

This manipulation therefore provides a good way to assess the relative contribution of first and second order processing for facial expressions of emotion and one which has only been employed once so far to look at expression perception.

9 AIMS OF THE CURRENT RESEARCH

As can be seen from reading the above introduction to the area of research with facial expressions, there already exists a considerable knowledge base. However, research has at best been very small and focused and at worst sporadic in its approach to facial expressions. Whilst the manipulations and methodology described above have all been used with facial identity research, many of them have also been extended into the realm of facial expression research (with the exception being rotation studies). However, there are inherent problems with the research area of facial expressions, as a whole.

The primary problem with facial expression research is the lack of standardisation across research in terms of the expressions of emotion employed. Vary rarely do researchers use all 6 of the basic (Ekman and Friesen, 1976) facial expressions of emotion, yet results are generalised to all expressions. Typically one or two expressions are employed and nearly always one of these is happiness, with which there is an acknowledged recognition advantage (Kirita & Endo, 1995). Secondly, there are no set stimuli employed across the research. Some researchers use line drawings/schematic faces (Etcoff & Magee, 1992; Parks, Coss & Coss, 1985; White, 1999, 2000), caricatures (Calder et al, 2000a), computer generated faces (Ellison & Massaro, 1997), mac-a-mug (or identi-kit) faces (Sjoberg & Windes, 1992) or photographic images (Calder et al, 2000b; McKelvie, 1995; Prkachin, 2003). As already discussed, some of these stimuli types have problems within themselves e.g. line drawings of expressions, with regard to their validity as representative of expressions. Combined with manipulations and different facial expressions, the results become difficult to generalise.

The primary aim of the current research is to investigate the influence of configural information and processing upon the recognition of facial expressions. By employing a standardised set of facial expressions and a consistent stimuli set (the Ekman and Friesen, 1976, pictures of facial affect set of the 6 basic facial expressions of emotion-anger, disgust, fear, happiness, sadness and surprise), and using each of the manipulations outlined above, it is hoped that the current research will go some way to answering the question of how facial expressions are processed-configurally, featurally, or a combination of both.

The thesis is structured into experimental chapters which each investigate the impact of configural or featural manipulations upon the recognition and processing of facial expressions of emotion. Investigations into the configural manipulations of the inversion effect, Thatcherisation and composite faces are presented in the first two experimental chapters. These chapters address the questions of whether configural manipulations impact participants' ability to recognise facial expressions of emotion, and whether there is evidence that some facial expressions are more 'configural' or 'featural' as previously suggested (McKelvie, 1995; Prkachin, 2003). Chapter three describes a spatial scale study where the manipulation of blur is applied to the facial expressions and the impact of this featural manipulation is investigated. Again, this chapter will address the question of whether some facial expressions are more reliant upon featural processing than others, or whether facial expressions can be seen as primarily configural, but this experiment employs a featural manipulation and not a configural one. Chapter four describes two studies which manipulate the type of configural information available within the facial expression. These experiments aim to address the question of whether facial expressions are more reliant upon a certain type of configural information (first order configural). The final chapter describes two rotation studies which are designed to investigate the question of whether there is a switch in processing between configural and featural at a certain angle of rotation, or whether there is a general decline in the ability to process facial expressions and facial expression features as they are inverted from upright.

The implications of the research and ideas for future work will then be discussed, along with a consideration of the application of the research.

Chapter Two

INVESTIGATING THE IMPACT OF INVERSION AND THATCHERISATION ON THE RECOGNITION OF FACIAL EXPRESSIONS OF EMOTION

10 ABSTRACT

This chapter details the first experiment conducted in the series. The aim of the experiment was to assess the impact of applying two of the most widely used configural manipulations upon the recognition of facial expressions of emotion. The experiment was designed to examine the famous facial inversion effect and to re-examine whether this effect holds across all six of the basic facial expressions of emotion and to examine the impact of the Thatcher illusion on expression recognition. The results of the experiment with these two manipulations provide evidence that all six of the facial expressions of emotion are primarily encoded and processed/recognised configurally.

11 INTRODUCTION

As discussed in chapter one, a large amount of research suggests that facial expression perception and recognition is primarily processed using a configural strategy, whilst also acknowledging the importance of the featural strategy. However, problems occur with facial expression research when certain expressions are omitted and conclusions are drawn on only a select set of expressions. This becomes extremely problematic when considering that some research (McKelvie, 1995; Prkachin, 2003) has suggested that different processing strategies may be specialised for different expressions. Therefore, the aim of the thesis is to investigate the role of configural and featural processing for each of the six facial expressions of emotion. The aim of the present experiment is to investigate whether configural manipulations impact participants' ability to recognise facial expressions of emotion, and whether there is evidence that some facial expressions are more 'configural' or 'featural' as previously suggested.

As already discussed there are numerous experimental effects which can be applied to faces in order to manipulate the type of information which is available from a face and the processing strategy which can be used to perceive it. Two of the most widely applied and researched are the facial inversion effect (Yin, 1969) and the Thatcher illusion (Thompson, 1980). Both have been vastly investigated in the facial identity research domain and the majority of researchers agree that both manipulations impair the ability to process faces using the configural strategy (Bartlett & Searcy, 1993; Lewis & Johnston, 1997; Murray, Yong & Rhodes, 2000; Rhodes, Brake & Atkinson, 1993; Searcy & Bartlett, 1996; Sergent, 1984).

11.1 Inversion and expressions

In the area of facial expressions both manipulations have also been used to investigate the way in which expressions are perceived, with varying conclusions. As already discussed in the introduction (pages 19-24) there is disagreement in the literature regarding the facial inversion effect for facial expressions. Whilst Prkachin (2003) reported a reduction in the ability to identify and detect all six of the basic facial expressions of emotion when they were inverted, other authors have found that this inversion effect is dependent upon which expression is being investigated. As can be seen from Table 1 numerous researchers have found this effect for varying expressions, but with very little agreement between studies.

Table 1. A comparison of the inversion effect found by different researchers for each of the six basic facial expressions of emotion and neutral expressions.

	Inversion Effect?	
Emotion	**Yes**	**No**
Anger	McKelvie (1995) Experiment 1 & 2) Prkachin (2003) White (1999) Fallshore & Bartholow (2003) Muskat & Sjoberg (1997)	
Disgust	McKelvie (1995) Exp 1 & 2 Prkachin (2003) Muskat & Sjoberg (1997)	Fallshore & Bartholow (2003)

Fear	McKelvie (1995) Exp 1 & 2 Prkachin (2003) Fallshore & Bartholow (2003)	Bartlett & Searcy (1993- reported as grotesqueness) Muskat & Sjoberg (1997)
Happiness	Prkachin (2003) White (1999) Fallshore & Bartholow (2003)	Bartlett & Searcy (1993) McKelvie (1995) Exp 1 & 2 Muskat & Sjoberg (1997)
Sadness	McKelvie (1995) Exp 1 & 2 Prkachin (2003) White (1999) Fallshore & Bartholow (2003) Muskat & Sjoberg (1997)	
Surprise	McKelvie (1995) Exp 1 Prkachin (2003) White (1999)	McKelvie (1995) Exp 2 Fallshore & Bartholow (2003) Muskat & Sjoberg (1997)
Neutral	McKelvie (1995) Exp 1 White (1999)	Bartlett & Searcy (1993) McKelvie (1995) Exp 2

Of course, as already acknowledged in the introductory chapter, a true comparison between these studies is difficult due to the differing methodologies employed to investigate the impact of inverting facial expressions.

The first study to investigate the inversion effect for facial expressions was conducted by Bartlett and Searcy (1993) and aimed to test the hypothesis that the perception of facial expressions is lost with inversion. Bartlett and Searcy employed three facial expressions from the Ekman and Friesen (1976) stimuli set. The stimuli employed were happy, neutral and what Bartlett and Searcy termed 'grotesque' facial expressions. In fact the grotesque expressions employed were actually fear expressions from the Ekman and Friesen set. The authors then used a grotesque rating task to investigate whether facial expressions can be perceived in inverted faces. Participants were asked to rate how grotesque faces were on a 7 point scale, both when upright and inverted. The hypothesis that facial expressions cannot be perceived when inverted would dictate that if this were true, the rated grotesqueness of expressions should be reduced when viewed inverted as the expressions would not be recognised. This, however, was not found. There was no difference between the rated grotesqueness of each of the three expressions (happy, neutral and grotesque/fear) when inverted compared to upright. Bartlett and Searcy (1993) therefore concluded that facial expressions can be recognised when inverted. The task employed with this study however, makes it difficult to compare the results with other research as this is not a typical inversion effect task and is quite different to tasks employed by other researchers.

A more typical inversion task was employed by McKelvie (1995) who used a recognition task to assess participant's ability to recognise all six of the basic facial expressions of emotion as well as neutral facial expressions, both upright and inverted. Participants were asked to identify the expression being portrayed by an actor whose face was displayed on a screen in front of a group of 15-20 participants. Responses were recorded by crossing through the name of the expression on answer sheets placed in front of each participant, with the list of expression names listed for each trial. This meant that no reaction time data was recorded and also participants were required to look away from the stimuli to record their answers, which could have acted as a distraction from the task. The first study conducted was a forced choice, between subject's design, which revealed an inversion effect for five of the emotional expressions and neutral, but not for happiness. McKelvie hypothesised that the lack of an inversion effect for happiness may have been due to inherent differences between the groups of participants and therefore conducted a replication of the study using a within subjects design. This study revealed an inversion effect for anger, disgust, fear and sadness, but not for happiness, surprise and neutral. McKelvie suggested that the expressions for which a consistent inversion effect had been found i.e. anger, disgust, fear and sadness, the expressions are based on configural information and reliant upon configural processing. Therefore when you invert these expressions and disrupt configural processing, the ability to recognise the expressions is impacted. Happiness and surprise, McKelvie (1995) suggested, are featural expressions which can be recognised on the basis of identifiable features e.g. the upturned mouth of a smile/happy face.

In 1997 a further recognition study on all six of the basic facial expressions was conducted by Muskat and Sjoberg. Muskat and Sjoberg, like McKelvie (1995) asked participants to identify which of the six facial expressions was being portrayed by faces presented upright and inverted. The authors found an inversion effect (reduced recognition rates) for three of the six expressions-anger, disgust and sadness; but no impact of inversion on the recognition of fear, happiness or surprise. Unfortunately, however, the brief description of this experiment does not explain what design, methodology or stimuli were used to ascertain whether there was an inversion effect for each expression; thus making this study extremely difficult to compare with other research.

Another task employed to investigate the inversion effect was a speeded go/no go task designed and employed by White (1999). This task required participants, who had been allocated to either the expression condition or the hair condition, to press a key if certain features were present in a face and another if they were absent (faces were presented upright and inverted). Participants in the expression condition were asked to press the go button if a face had eyebrows and a mouth and to press no go if these features were absent; likewise participants in the hair condition were asked to press the go button if the hair in the picture was dark and no go if the hair in the picture was light. White argued that by minimising the amount of semantic information participants have to process (by utilising only certain facial features and not full expressions) he avoided the confound of participants recognising the expressions via a semantic route e.g. recognising happiness because a semantic network recognises it as representing positive affect. However, White then confounded the study by only employing three facial expressions of emotion (happy, sad and angry) and neutral expressions. Further, participants were not informed that there were different expressions being employed and their task was not to make a judgement of the expressions being displayed, merely to indicate if two facial features were present or not. The stimuli employed in this study were line drawing of faces and expressions were ‘created’ by altering the shape of the eyebrows and mouth, which calls into question the ecological validity of the stimuli but also of the expressions which were created. Reaction time analysis revealed that when expressions were viewed in the inverted orientation latencies were increased, with no such effect seen for the hair condition. White suggested that these results indicated that expressions are represented and encoded as undecomposed wholes and thus susceptible to the inversion effect which reduces configural processing. However, as already acknowledged, participants were not asked to differentiate between the expression being presented and therefore the results of the study are somewhat confusing, as what they actually reveal is that when faces are inverted participants take longer to decide whether two facial features are present or not.

Fallshore and Bartholow (2003) also employed line drawings as stimuli for their investigation of the mode of processing used for facial expressions. The stimuli were line drawings of the expressions with each face containing eyes, eye brows, nose and mouth but no other features or contextual information. These schematic drawings were then shown to participants on a slide projector and participants were asked to circle, in an answer booklet, which of the six emotions the face was portraying. Participants had previously been assigned to one of two groups, upright presentation or inverted presentation, therefore utilising a between subjects design. Overall these authors report an inversion effect (i.e. reduced recognition in the inverted orientation) for facial expressions; but for individual expressions the effect only held for anger, fear, happiness and sadness and not for disgust or surprise. Again, however, there are problems with the methodology, such as the unrealistic stimuli which depict only four facial features, and also the use of a between subjects design where inherent participants differences could account for the observed effects.

Prkachin (2003) conducted an inversion effect study where two experiments using signal detection procedures were reported, the first was a traditional inversion effect recognition task and the second was a detection task. The Ekman and Friesen (1976) pictures of facial affect were employed as stimuli and all six of the basic facial expressions of emotion were included. In the first study participants were asked to identify the emotion being portrayed by the face, in both upright and inverted orientations. Participants saw the facial expressions presented on a video and said their response to the expression out loud, which was then recorded via an audio tape. Prkachin found that recognition accuracy was reduced for all six of the expressions when they were inverted, with the impact being greater for anger, disgust and fear. In the second experiment a detection task was employed to reduce the amount of processing demands being made on participants. In this study the task was to say ‘yes’ when a target facial expression was presented. Each participant was assigned their target expression randomly and then saw a set of facial expressions which included all six of the expressions, both upright and inverted. Therefore in the second experiment the design was between subjects, again raising the problem of participant differences. Again an inversion effect of reduced accuracy at identifying the emotion, for all six of the expressions was reported. The use of signal detection procedures makes this study difficult to compare to the other research on the inversion effect for facial expressions, as this is the only study to employ signal detection theory. Further, this is the only study to use a detection task for expressions and inversion, again making comparison difficult.

The main problems are therefore the lack of a standardised set of stimuli which are used across studies, with some authors using the Ekman and Friesen (1976) faces, some employing different photographic images, some using line drawings, and again not all researchers employ the same facial expressions of emotion. One study even employed line drawings of faces with only 4 facial features depicted (Fallshore and Bartholow, 2003). Different designs have also been employed across studies, with some using within subjects designs and others between subjects, or even using the different designs within the same research (McKelvie, 1995). To impact upon the potential comparisons even further, the methods used also vary greatly, with some researchers employing computer based tasks which allow for precision and response time recordings, some using a pencil and paper task; and each study employing different time limits for participants to view faces. Finally, the way in which the inversion effect is measured has also not been standardised across studies. For example, Bartlett and Searcy (1993) used ratings of how grotesque expressions looked whilst upright and inverted to measure whether this quality was subject to an inversion effect, Prkachin (2003) utilised a recognition and a detection task, White (1999) employed a feature detection task; making comparisons increasingly more difficult.

The aim of employing the facial inversion effect in the current study was therefore to re-assess the effect of this manipulation on the recognition of facial expressions of emotion, whilst using a consistent set of stimuli, expressions and a consistent methodology (all of which are employed throughout the experimental series). The use of all six basic facial expressions of emotion from the Ekman and Friesen (1976) set, will address the problem that is often found with expression research-that of not employing all of the basic expressions or justifying the selected expressions employed. The use of this set of stimuli will also make the results of the study comparable to both McKelvie's (1995) results and Prkachin's (2003). The study will employ a forced choice procedure, similar to that used by McKelvie; however, responses will be computer based allowing precise reaction time recordings and avoiding confounding attention problems. This would not be possible if replicating either the McKelvie or Prkachin methods. Further, in the McKelvie (1995) study a response category of neutral was included (although there were no neutral faces in the stimuli set); however, in the present study this category was omitted as research has suggested that the inclusion of an extra response category is not necessary (see the review of the forced choice method below). Finally, the task employed was the same as that used by both McKelvie and Prkachin, a recognition test. Therefore, the results of the current study will be both comparable with and an extension of earlier research.

If, as some authors have suggested (McKelvie, 1995; Prkachin, 2003) certain facial expressions (happiness and surprise) are based on featural information whilst others are more configural based (e.g. anger, disgust, fear and sadness) then different inversion effects would be expected. Specifically it would be predicted that if the expressions of happiness and surprise are more reliant on individual, identifiable features there would be no inversion effect found for these expressions. If however, facial expressions are processed configurally then inverting the expressions will significantly reduce recognition across all expressions.

11.2 The Forced choice method

As forced choice methodology is employed throughout the thesis a review of this method is presented in order to familiarise the reader with the method and to ascertain the validity of it.

The most widely used experimental method for exploring face recognition is the use of the forced choice paradigm. This is where participants are presented with a set of faces, or facial expressions, provided with a list of labels (e.g. names, emotion labels) and asked to apply a label to each stimulus. A typical facial expression experiment involves the presentation of a number of faces depicting emotional expressions and the participant’s task is to respond to the face, as quickly and accurately as possible, with which expression they believe the face is showing. This method is also used with studies in which faces have been manipulated, to investigate the effects of manipulations on the ability to recognise and categorise faces or emotions.

The forced choice method for facial expressions has attracted criticism however. Frank and Stennett (2001) provided a large-scale review of the methodology of the forced choice procedure. These authors found that the criticism of the forced choice method revolves around the problem of artificial agreement amongst observers. This is the fact that if one of the emotion labels is removed from a forced choice study e.g. fear, then participants usually still artificially agree on another label for that expression e.g. surprise (Russell, 1993). Frank and Stennett (2001) therefore employed a modified forced choice method to investigate these claims. By including a 'get out' option these authors allowed participants the chance to choose not to artificially agree to any emotion labels. All 6 of the basic facial expressions proposed by Ekman and Friesen (1976) (anger, disgust, fear, happiness, sadness and surprise) were included as stimuli in the experiments, and all 6 of these emotion labels along with a 'none correct' label were employed. Frank and Stennett found that the inclusion of a 'none correct' option did *not* significantly alter the pattern of agreement between their participants and furthermore that these patterns of agreement were not significantly different from those reported by other studies which employed the traditional forced choice method. Secondly, it was found that participants did make use of this 'get out' option, but only when it was appropriate i.e. when the correct emotion label had been removed. Therefore, by including this additional option, these authors avoided the problem of artificial agreement on one emotional expression when the correct option was not available. It was also found that if participants were presented with a novel or non-sense facial expression, there was no artificial agreement on an emotional label, rather the 'none correct' option was chosen for those novel/non-sense expressions. Frank and Stennett therefore advocate the use of the forced choice method, but suggest that an additional option like the one they used should be included.

However, it would seem that the addition of a 'get out' option is not necessary for all experiments. In the studies described by Frank and Stennett there was real concern that participants may agree artificially on an incorrect emotion label e.g. due to the lack of a correct label for an expression or due to a novel expression which also did not have an appropriate label in the list of options available. If a study is being conducted which does not include these problematic variables then the use of the traditional forced choice paradigm will be sufficient. As long as the categories or labels that are present are comprehensive enough to cover all of the expressions involved, then the forced choice method is a good empirical technique (Wagner, 1997). In the present investigations within this thesis, no such studies are conducted and all of the expressions employed have a relevant label available; therefore no 'get out' option is required. Indeed, Frank and Stennett (2001) found that participants agreed at levels above chance that particular facial configurations did represent the facial expressions they were intended to even when participants were not forced into choosing an emotion option.

Frank and Stennett (2001) concluded that the forced choice method is simple, clear and methodologically strong and produces meaningful results; therefore, it has been adopted as the experimental method throughout the present thesis.

11.3 Thatcherisation and expressions

It would seem that a suggestion which falls out of some of the Thatcher illusion studies is that the featural processing of the features of the inverted Thatcher stimuli may actually reduce the perceived grotesqueness of the face as they are in fact upright normal components (Bartlett & Searcy, 1993; Murray, Yong & Rhodes, 2000). As proposed in the introduction (page 42 & 44), when a Thatcher face is seen in the normal upright orientation configural processing immediately detects the disrupted configural information and the perception of strangeness ensues. However, when the whole face is inverted (and configural processing is disrupted), the features are now upright in relation to the viewer (although not the face context) and the featural processing strategy processes the facial features and not their configuration in relation to the face and other features, therefore the perception of strangeness is vastly reduced. Consequently the present study also investigated the detection of facial expressions in the Thatcher illusion.

To date only one study has employed the Thatcher illusion to investigate the impact of the illusion on expressions, that of Muskat and Sjoberg (1997). However, the aim of their study was not the recognition of the emotions and the way in which the illusion impacted upon that, but rather, the impact of inversion on featural information. These authors compared participants' performance on normal upright faces and normal inverted faces to ascertain whether they could find the classic facial inversion effect. They report the inversion effect for only three expressions-anger, disgust and sadness; with no effect on happiness, fear or surprise. Muskat & Sjoberg were interested in whether inversion impairs the processing of featural information and therefore compared participants' recognition of expressions in normal inverted faces and Thatcherised inverted faces. They reasoned that if inversion impairs the ability to process features, in Thatcher inverted faces (where the features remain upright) there should be no such impairment; therefore, inverted Thatcher faces should be recognised with more accuracy than inverted normal faces. However, they concluded that component information is not used in the processing of inverted faces, as no difference was found between normal and Thatcherised inverted faces. This conclusion is in complete disagreement with the majority of researchers who postulate that inverted faces and facial expressions are processed featurally.

One criticism of the Muskat & Sjoberg (1997) study is the failure to compare faces in which the features are in the same orientation, but the face context is not e.g. normal upright faces and inverted Thatcher faces; to assess the impact of feature inversion upon expression recognition. Leder, Candrian, Huber and Bruce (2000) have previously found that participants' judgement of the interocular distance is not impaired with inverted Thatcher faces compared to normal upright faces, and conclude that the inversion effect only occurs when features are inverted. Therefore the present study will provide an empirical investigation of the impact of featural inversion upon facial expression recognition.

If inverted faces are processed featurally then it would be expected that (at least some) facial expressions would be more recognisable from an inverted Thatcher face than from a normally inverted face-due to the upright featural information in the Thatcher illusion when inverted. Previously McKelvie (1995) has suggested that the expressions of happiness and surprise are more featural than configural, and if this is so, then these expressions might be expected to be more recognisable than others which are thought to be more configurally based (e.g. anger and sadness). Therefore, it is anticipated that this first experiment will provide a thorough investigation of the recognition of facial expressions of emotion under conditions where configural information and processing are impaired.

12 METHOD

12.1 Participants

Forty-four participants took part in the study, 35 females and 9 males. All participants were in the age range of 18 to 45 years old and were undergraduate students at the University of Wolverhampton. Participation in the study was rewarded with course credits. Participants all had normal or corrected to normal vision.

12.2 Stimuli

Facial expression stimuli were taken from the FEEST (Facial Expressions of Emotion) program (York, Perrett, Calder, Sprengelmeyer & Ekman, 2002) and consisted of 10 actors portraying 6 emotions (anger, disgust, fear, happiness, sadness and surprise). The faces were manipulated using Photoshop to create inverted and Thatcherised faces (in which the eyes and mouth were inverted). In total there were 240 experimental stimuli, 60 normal upright faces, 60 normal inverted faces, 60 upright Thatcherised faces and 60 inverted Thatcherised faces. For the practice trials the stimuli were taken from the mind reading program (Baron-Cohen, 2002) and 40 faces were used. These stimuli consist of various actors portraying the six basic facial expressions of emotion (although the mind-reading stimuli do include examples of other facial expressions, these were not included). The actors chosen were similar ages to those used in the Ekman and Friesen pictures and were also matched for gender. The images were also the same size as those used for the experimental stimuli. Examples of the experimental stimuli can be seen in Figure 4.

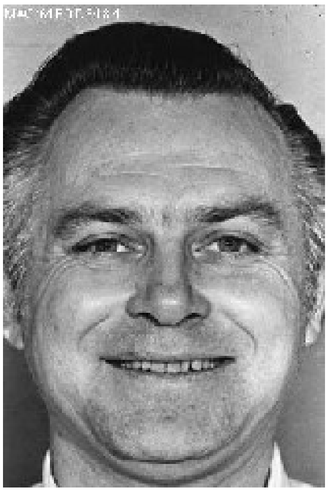

Figure 4a

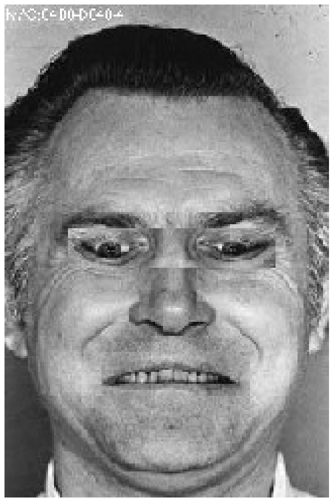

Figure 4b

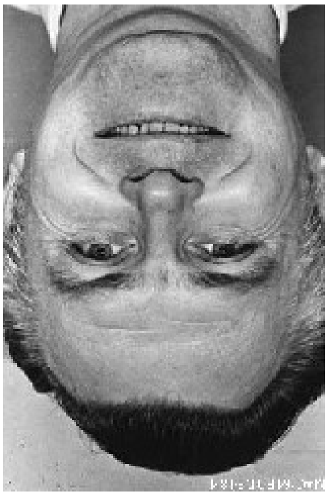

Figure 4c

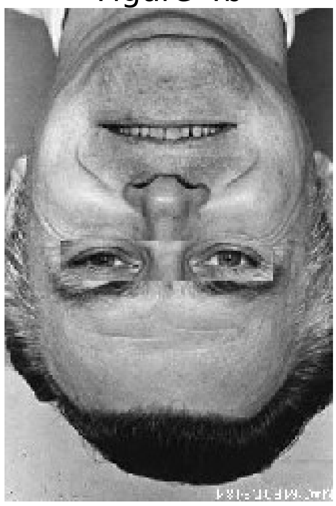

Figure 4d

Figure 4. Examples of experimental stimuli using a happy face from Ekman and Friesen (1976), 4a = upright unmanipulated face, 4b = upright Thatcher face, 4c = inverted unmanipulated face 4d = inverted Thatcher face.

12.3 Procedure

The experimental session consisted of 40 practice trials and 240 experimental trials. The practice trials consisted of primarily upright faces to familiarise participants with the expressions (28 upright and 12 inverted). The practice trials were randomly generated, with a minimum of 6 examples of each expression being presented to each participant. The experiment was programmed using Superlab.

Each trial consisted of the presentation of a single face above 6 coloured squares. On each square was displayed the name of an emotion e.g. happy, sad etc. These coloured squares represented the response keys (on the number pad of the keyboard) and participants were instructed to press the coloured key that represented the emotion they believed the face to be showing.

Each experiment began with an instruction screen informing the participant that when they pressed a key the practice trials would begin. The first face appeared once the participant pressed any key. The participants' task was to indicate as quickly and as accurately as possible which expression each face was displaying. Each stimulus remained on the screen until a response was made, at which point a blank screen was shown for 30 seconds, before the next presentation began. Once the practice trials had been completed, another instruction screen appeared, indicating that when a key was pressed the experiment proper would begin. The experiment proper consisted of 240 trials presented in random order. The task was the same as for the practice trials. At the end of the 240 trials a screen indicated that the participant had completed the experiment and they were thanked for their time.

The participants' responses were recorded for each trial as well as reaction time data.

13 RESULTS

Accuracy scores were collected for this study by counting the number of correctly identified expressions for each participant. Correct recognition of the expressions was defined as recognition of the original expression shown on the face, regardless of manipulation applied. Mean correct recognition scores for each expression are shown in Table 2 and mean reaction times (once log transformed) can be seen in Table 3.

Table 2. Mean number of correct expressions identified in each condition (Note. Maximum score = 10)

	Anger	**Disgust**	**Fear**	**Happiness**	**Sadness**	**Surprise**
Normal Upright	7.705 (sd. 1.786)	7.364 (sd. 2.304)	6.727 (sd. 2.336)	9.795 (sd. 0.823)	7.364 (sd. 1.780)	8.432 (sd. 1.500)
Normal Inverted	5.795 (sd. 2.258)	4.227 (sd. 2.240)	3.750 (sd. 2.651)	9.432 (sd. 1.169)	4.886 (sd. 2.071)	7.409 (sd. 2.015)
Thatcher upright	4.636 (sd. 2.136)	6.318 (sd. 2.586)	5.205 (sd. 2.064)	3.500 (sd. 2.774)	4.977 (sd. 1.911)	6.045 (sd. 2.011)
Thatcher inverted	5.227 (sd. 1.878)	5.386 (sd. 2.634)	4.091 (sd. 2.331)	7.795 (sd. 2.775)	6.477 (sd. 2.445)	7.159 (sd. 1.765)

Table 3. Mean reaction times to recognise each expression, in each condition (log transformed data)

	Anger	**Disgust**	**Fear**	**Happine**	**Sadnes**	**Surprise**

				ss	s	
Normal Upright	3.348 (sd.0.128)	3.297 (sd. 0.119)	3.398 (sd. 0.133)	3.178 (sd. 0.122)	3.323 (sd. 0.123)	3.329 (sd. 0.119)
Normal Inverted	3.389 (sd. 0.141)	3.388 (sd. 0.159)	3.402 (sd. 0.207)	3.235 (sd. 0.127)	3.433 (sd. 0.194)	3.351 (sd. 0.129)
Thatcher upright	3.415 (sd. 0.180)	3.371 (sd. 0.153)	3.466 (sd. 0.163)	3.516 (sd. 0.262)	3.409 (sd. 0.169)	3.418 (sd. 0.168)
Thatcher inverted	3.434 (sd. 0.139)	3.401 (sd. 0.177)	3.463 (sd. 0.190)	3.331 (sd. 0.146)	3.472 (sd. 0.175)	3.395 (sd. 0.138)

Table 3 displays the mean (log transformed) reaction times to each of the expressions under all four experimental conditions; and it can be seen that there was very little variation in reaction times across the four manipulations. It is interesting to note that the happy expression had the fastest reaction times in three of the four manipulations (normal upright, normal inverted and Thatcher inverted) yet it had the longest latency in the Thatcher upright condition.

13.1 Analyses

The correct recognition scores data was submitted to individual two-way repeated measures analysis of variance tests, one for each of the six facial expressions, with the factors of orientation (upright versus inverted) and condition (Thatcher versus normal).

The ANOVAs revealed a significant main effect of condition for the expressions of Anger $F_{(1, 43)} = 65.806$, $p < 0.0005$), Fear $F_{(1, 43)} = 4.191$, $p < 0.05$), Happiness $F_{(1, 43)} = 154.830$, $p < 0.0005$), and Surprise $F_{(1, 43)}$

= 58.140, $p < 0.0005$); but not for disgust ($p = 0.778$) and sadness ($p = 0.130$).

A significant main effect of orientation was found for Anger $F_{(1, 43)} = 9.740$, $p < 0.005$), Disgust $F_{(1, 43)} = 67.954$, $p < 0.0005$), Fear $F_{(1, 43)} = 70.735$, $p < 0.0005$) and Happiness $F_{(1, 43)} = 57.942$, $p < 0.0005$); but not for sadness ($p = 0.065$) and surprise ($p = 0.845$).

These ANOVAs also revealed significant interactions between orientation and condition for each of the six facial expressions: Anger ($F_{(1, 43)} = 39.548$, $p < 0.0005$), Disgust ($F_{(1, 43)} = 46.170$, $p < 0.0005$), Fear ($F_{(1, 43)} = 20.084$, $p < 0.0005$), Happiness ($F_{(1, 43)} = 96.434$, $p < 0.0005$), Sadness ($F_{(1, 43)} = 78.148$, $p < 0.0005$) and Surprise ($F_{(1, 43)} = 28.863$, $p < 0.0005$).

The interaction results can be seen in Figure 5 which reveals the same pattern of results for the expressions of anger, happiness, sadness and surprise of upright normal faces having higher recognition accuracy than inverted normal faces, whilst the opposite is true of Thatcher faces (inverted recognised with more accuracy than upright Thatcher). Disgust and fear deviate from these patterns as upright Thatcher faces had higher recognition accuracy than inverted Thatcher faces.

Anger **Happy**

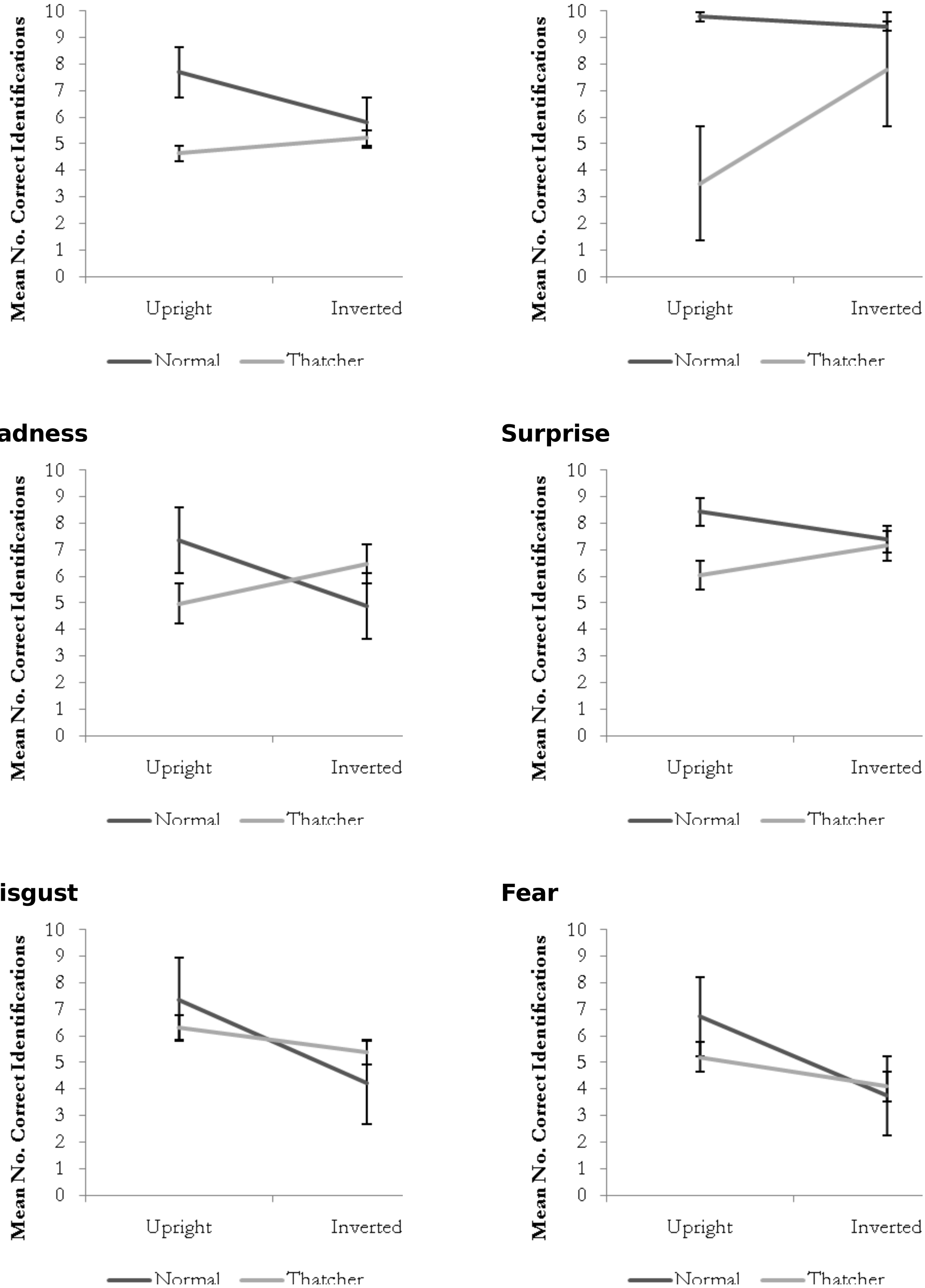

Figure 5. Mean correct recognition scores for each expression in both normal and Thatcherised conditions, and in upright and inverted orientations.

13.2 Follow up analyses

It was necessary to conduct further analyses on the data as various predictions had been made regarding specific effects on each facial expression; t-tests were used to complete the comparisons. These follow up analyses were subject to Bonferroni correction, which set the alpha value at 0.0083.

The first follow up analysis investigated the classic facial inversion effect for facial expressions by comparing normal upright faces with normal inverted faces. If there was an inversion effect then recognition would be significantly reduced in the inverted orientation.

The second comparison followed the studies of Leder et al. (2001) and Muskat and Sjoberg (1997) by comparing recognition of normal inverted faces and inverted Thatcher faces, to see whether there was any facilitation with the upright components in Thatcher faces.

Finally, upright normal faces were compared to inverted Thatcher faces to assess the impact of features of the same orientation, with facial contexts of different orientations.

An analysis of the effect on expression recognition of Thatcherising a face was also conducted (comparison of normal upright and Thatcher upright expressions), and as expected there was a significant reduction in the ability to recognise each of the six facial expressions, all at the 0.000 level of significance. This analysis is not reported in full as it was never an intention of the study to investigate this seemingly obvious effect, but it is acknowledged that it was important to check that the effect would be seen.

13.2.1 Facial Inversion Effect

Comparing correct recognition scores for normal upright and normal inverted faces revealed an inversion effect (i.e. significantly reduced accuracy with inverted faces) for all six of the facial expressions. Anger (t = 6.196, df = 43, p < 0.0005, two tailed); Disgust (t = 10.427, df = 43, p < 0.0005, two tailed); Fear (t = 8.596, df = 43, p < 0.0005, two tailed); Happiness (t = 3.216, df = 43, p = 0.002, two tailed); Sadness (t = 6.857, df = 43, p < 0.0005, two tailed); and Surprise (t = 4.078, df = 43, p < 0.0005, two tailed). This can be seen in Figure 6.

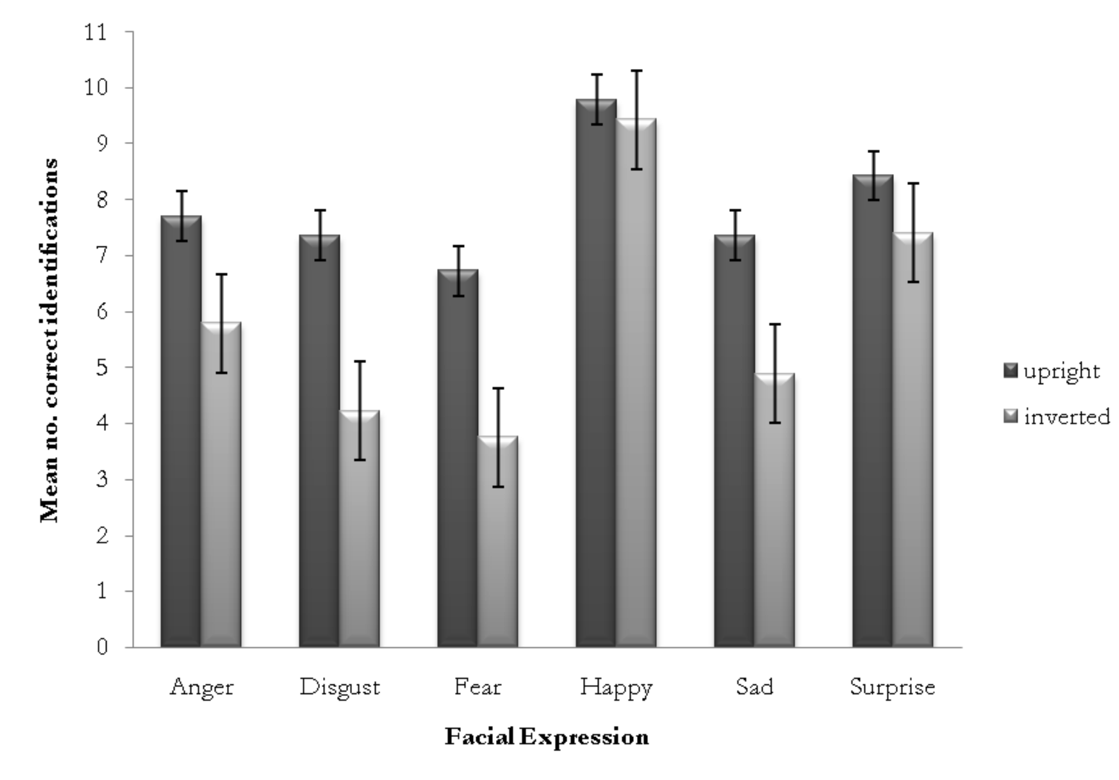

Figure 6. The inversion effect: recognition of facial expressions of emotion (no manipulation applied) in upright and inverted orientations

13.2.2 Featural Information Facilitation

Comparisons revealed a significant difference between recognition of inverted normal and inverted Thatcher faces for the expressions of disgust (t = -4.458, df = 43, p < 0.0005 two tailed), happiness (t = 4.330, df = 43, p < 0.0005 two tailed) and sadness (t = -4.389, df = 43, p < 0.0005 two tailed). However, there was no significant difference for the expressions of anger (t = 1.880, df = 43, p = 0.067 two tailed), fear (t = -0.903, df = 43, p = 0.372 two tailed) and surprise (t = 1.185, df = 43, p = 0.243 two tailed). The pattern of results for each expression can be seen in Figure 7. For the expressions which revealed significant differences (disgust, happiness and sadness) it can be seen that for happiness the normal inverted faces were recognised with more accuracy than Thatcher inverted faces; however, for disgust and sadness this trend was reversed. This pattern can also be seen for the fear expression, although this difference was not significant; for the other non significant differences between surprise and anger the same pattern as for happiness emerged, that is the normal inverted faces were recognised with more accuracy than the inverted Thatcher faces.

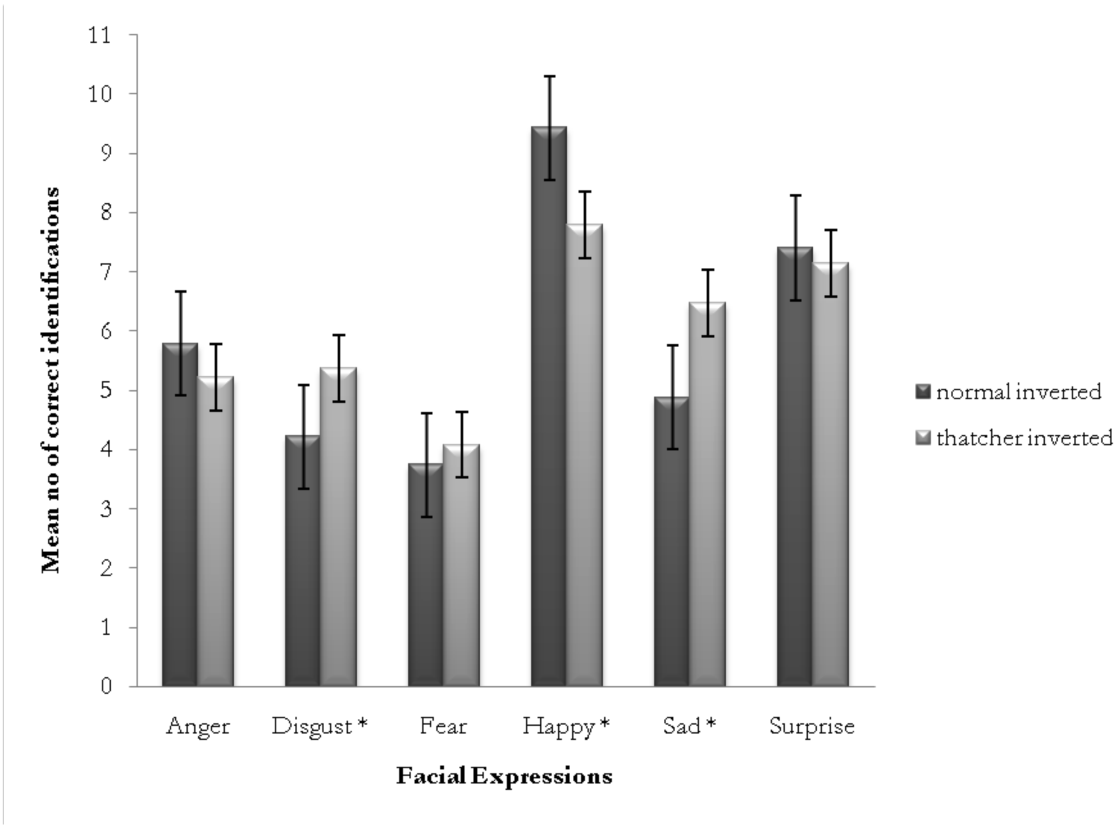

Figure 7. Comparison of mean correct recognition scores for normal inverted faces and Thatcher inverted faces, for each of the six facial expressions. * denotes a significant difference

13.2.3 Thatcher Inversion Effect

A significant Thatcher inversion effect (i.e. reduced recognition with inverted Thatcher faces compared to normal upright faces) was found for five of the six facial expressions of emotion-: Anger (t = 9.415, df = 43, p < 0.0005 two tailed), Disgust (t = 6.954, df = 43, p < 0.0005 two tailed), Fear (t = 6.827, df = 43, p < 0.0005 two tailed), Happy (t = 5.039, df = 43, p < 0.0005 two tailed), Surprise (t = 5.168, df = 43, p < 0.0005 two tailed). There was no significant difference for sadness (t = 2.167, df = 43, p = 0.036 two tailed). Previously Leder et al (2001) had found that the inversion of components was necessary for the inversion effect to occur; however, the present data suggests that this is not so for facial expressions. It is possible that a recognition task does not preclude featural processing, but perhaps the interocular distance judgement task does.

14 DISCUSSION

One of the primary aims of experiment one was to re-investigate the facial inversion effect for facial expressions of emotion due to conflicting results reported by various researchers. It was found that inversion did reduce participants' ability to recognise facial expressions of emotion, thus replicating the effect found by numerous researchers (Bartlett & Searcy, 1993; Fallshore & Bartholow, 2003; McKelvie, 1995; Muskat & Sjoberg, 2000; Prkachin, 2003; White, 1999). The present study found an inversion effect for all six of the basic facial expressions of emotion, with a more pronounced effect for the expressions of anger, disgust, fear and sadness. Therefore fully replicating the results of Prkachin (2003) but providing conflicting results with some research. Previously Bartlett and Searcy (1993), Fallshore and Bartholow (2003) and McKelvie (1995) had reported null inversion effects for the expression of happiness and/or surprise. Whilst in the present study the effect on the recognition of happiness was minimal, the reduction in recognition did reach significance which was also true of surprise.

As already discussed in the introduction (pages 17-25), the facial inversion effect is employed as a robust manipulation of configural processing, and the fact that all six of the expressions showed an inversion effect suggests that the basic facial expressions of emotion are processed configurally. Even the expressions of happiness and surprise which McKelvie (1995) and others (Bartlett & Searcy, 1993; Fallshore & Bartholow, 2003) have not reported inversion effects for were disrupted with inversion in the present study. McKelvie (1995) proposed that the expressions of happiness and surprise did not show inversion effects as they were based on identifiable components, e.g. upright mouth, wide open eyes, which are identifiable in both upright and inverted faces, and the processing of these expressions is therefore not subject to the inversion effect. However, as no such conclusion was reached in the present study, this supposition cannot be supported and therefore evidence has not been provided for ‘featural’ facial expressions as such by this part of the present study.

However, the fact that the recognition of happiness and surprise remained at very high levels even when inverted (96% and 87% respectively) does provide support for the notion that the identifiable features of these expressions make them less susceptible to the inversion effect, compared to other less ‘featurally unique’ expressions (such as anger and disgust, which are often confused). The fact that participants were more accurate at recognising the facial expression of happiness than any other expression is not surprising given the literature on the ‘happy face advantage’ (Feyereisen, Malet and Martin, 1986; Kirita and Endo, 1995). The pattern of results reveals that the four expressions of anger, disgust, fear and sadness were impacted to a much greater extend by inversion (recognition was reduced to between 75% and 54% with these expressions) than were happiness and surprise. In agreement with results reported by Prkachin (2003) these were the expressions which were recognised with less accuracy when upright too and therefore inversion could reflect a general decline in the ability to process expressions.

However, when the configural strategy is disrupted, participants still recognised the facial expressions at above change level (i.e. higher than 1/6 chance of choosing the correct facial expression by chance. However, as previous research and this study have suggested- happiness is very rarely confused, therefore chance may be considered as 1/5; which still means the expressions are recognised above chance level), thus suggesting that another processing strategy is employed when configural cannot be used. Based on previous research it is suggested that this processing strategy is most likely featural.

14.1 The Thatcher illusion

The Thatcher illusion provided a somewhat different investigation of the inversion effect, due to the fact that in an inverted Thatcher face the components or features remain in their normal upright position. To assess the proposition that the upright features in an inverted face may possibly facilitate recognition compared to an inverted normal face in which both the features and the face context are inverted, a comparison of participants' performance on these two inverted stimuli was conducted. This revealed that for the expressions of disgust and sadness, inverted Thatcher faces were accurately recognised significantly more than in the normal inverted version of that face. This same pattern also held for the expression of fear, although this result was not significant. For the expressions of happiness, with normal inverted faces being recognised with more accuracy. Again, although not a significant result, for the expressions of anger and surprise the same pattern of results was observed with normal inverted expressions being recognised with more accuracy than inverted Thatcher expressions.

Previously Muskat and Sjoberg (1997) had found no differences between inverted normal and inverted Thatcher faces across all six expressions and had concluded that either component information had not been used to process the inverted faces or that the use of component information was reduced by the use of another processing strategy i.e. mental rotation. The present study does not support these conclusions, as some of the facial expressions were recognised with more accuracy in the inverted Thatcher faces; and the inversion effect had been found for all six of the expressions, suggesting that configural information had been disrupted. However, the suggestion that the upright featural information within an inverted Thatcher face may facilitate recognition for certain expressions which contain identifiable individual features (i.e. happiness and possibly sadness) was not justified. Both of these expressions were recognised with more accuracy in the inverted normal condition than the inverted Thatcher.

Employing the Thatcher illusion has demonstrated that facial expression recognition is extremely robust, with recognition above chance even with Thatcherised faces, in which past research has demonstrated there is an air of grotesqueness, which it might be thought would disrupt expression recognition or processing. It would seem that, contrary to Leder et al. (2000), inversion of the face but not the features with facial expressions is enough to disrupt recognition, suggesting that configural processing is vital to facial expressions. The comparison between inverted normal and inverted Thatcher faces suggests that there was only facilitation for the recognition of disgust and sadness with upright features in an inverted face compared to a completely inverted face, therefore again suggesting that overall configural processing is important to facial expressions, and that for the majority of expressions upright featural information cannot eradicate this disruption.

15 SUMMARY

The results from the facial inversion effect and the Thatcher illusion with facial expressions both indicate that all 6 facial expressions of emotion can be processed configurally and are disrupted by manipulations of configuration. In addition, the high recognition rates with configurally disrupted faces also suggest that another processing mode can be employed with facial expressions, when the primary processing strategy of configuration is not available. This assumption was further investigated in experiment two, using the composite effect for facial expressions. The composite effect is another extremely robust configural manipulation and was employed to further test the hypothesis that some facial expressions may be more reliant upon configural processing, whilst others may be more reliant upon featural.

Chapter Three

CONFIGURAL PROCESSING OF COMPOSITE FACIAL EXPRESSIONS

16 ABSTRACT

This chapter presents a further robust test of the impact of configural processing upon the recognition of facial expressions of emotion. In the present experiment the composite effect was employed as a direct manipulation of the processing strategy employed with expressions. The experiment was designed to investigate whether the composite effect (reduced recognition of expressions when they are aligned into a composite image) holds even when the expressions in the composite are proposed to rely more on identifiable components than on configural properties. The results of this experiment further support the dual mode hypothesis and suggest that facial expressions are primarily processed configurally.

17 INTRODUCTION

One of the most direct ways in which to assess the importance of configural information and configural processing for facial expression recognition is the use of facial composites. The composite effect occurs when two face halves are combined to form a ‘new’ face configuration and the time taken to recognise either half of the face is increased compared to if the composite is presented inverted, misaligned, or the two face halves are presented individually. It has been proposed (Young et al., 1987; Calder et al., 2000b) that the composite effect occurs because composites are perceived as a whole face, which then encourages configural processing of the image. As the new face image is not consistent with any stored facial configuration the time to recognise either face half is increased, this is because the first processing strategy employed (configural) would not provide the information needed and therefore a switch in the strategy would be needed-increasing the time taken to perceive and recognise the face. Therefore, the featural information in the two face halves is not processed immediately which would lead to faster recognition. When configural processing is disrupted, by misaligning the composite face or inverting it, the overall impression of a single configuration is lost, and individual information from the separate faces can be accessed, therefore leading to much faster recognition rates.

Whilst a large amount of research has been conducted on the composite effect for facial identity recognition and processing, the use of composites as a research tool for facial expression work has received little attention. The small amount of research that has been produced has also limited the generalisability of the study by only combining certain facial expressions. Calder et al. (2000b) used facial expressions that are readily identifiable from the top or bottom half of the expression. The bottom half recognisable expressions were happiness, disgust and surprise and the top half recognisable were anger, sadness and fear. When Calder et al. combined one of the top half recognisable emotions with one of the bottom half they found a reliable composite effect (i.e. participants took longer to name the expression in the top or bottom half of an aligned or upright composite than in a misaligned or inverted image). Thus, indicating that facial expressions are also subject to the composite effect and therefore reliant upon configural information. The composite effect was found across all the expression combinations they employed i.e. a happy bottom half with an anger, sad or fear top half etc.

However, previous research has suggested that facial expressions are differentially reliant upon configural information (Endo et al., 1995; McKelvie 1995), which could therefore have an impact upon the composite effect. Specifically it has been suggested (Endo et al., 1995; McKelvie 1995; Prkachin, 2003) that the facial expressions of happiness and surprise are more based upon identifiable features than they are upon configural information. The results of the experiment reported in chapter two however, do not robustly support the proposition that some expressions are differentially reliant upon different types of information and processing. The results of applying the facial inversion effect suggested that all six of the basic facial expressions of emotion are processed configurally and any disruption in the ability to employ this processing mode disrupts participants' ability to recognise the expressions. Although it should be noted that the inversion effect for happiness and surprise was much less pronounced than for the other four expressions in the first experiment. Further, by employing the Thatcher illusion it was found that the expressions of disgust and sadness were more recognisable in an inverted Thatcher face (inverted face with upright features) compared to an inverted normal face, suggesting some potential facilitation with upright featural information for these two expressions. However, whilst previous research had indicated that sadness may be a more featural expression (Endo et al., 1995), there was no indication that disgust may be more reliant upon featural information and processing, therefore this finding will be further investigated by the present study.

In the previous expression composite study (Calder et al., 2000b) the combination of facial expressions employed consisted of ones which have been suggested by previous research to be more featural (e.g. happiness and surprise) combined with ones proposed to be more configural (e.g. anger, fear or sadness). This resulted in combinations of either two ‘configural’ expressions or one ‘configural’ and one ‘featural’ expression. This meant that there was always one facial expression present for which the primary processing strategy was configural. Therefore experiment two was designed to assess the impact upon the composite effect of using two facial expressions which are proposed to not be primarily reliant upon configural processing.

Experiment two therefore employed composites made of two 'featural' expressions (happiness and surprise) or two 'configural' expressions (anger and sadness), to ascertain if the composite effect would still occur. Whilst experiment one in the present thesis suggested that the expressions of happiness and surprise are not more reliant upon featural processing than configural, it is also acknowledged that this conclusion needs further investigation. Thus employing these two expressions will further test the hypothesis that they are in fact configural based and not featural. With the expressions of anger and sadness, again these have both been proposed to be configurally based expressions, but in experiment one it was found that the recognition of sadness was facilitated with upright features. It is possible therefore that sadness is more reliant upon featural information, and again this proposition can be further tested in the current study.

If certain expressions are primarily featural then it would be a reasonable expectation that the composite effect would not be so strong with these expressions, as the featural information might be expected to be prominent enough to over-ride the impression of a new configuration. However, a composite effect is expected with both types of stimuli (featural and configural) as research has shown the effect to be extremely robust and the results from experiment one would indicate that all of the expressions are primarily based upon configural information and processing.

18 METHOD

18.1 Participants

Thirty six participants took part in the study, 30 females and 6 males. All participants were in the age range of 18 to 49 years old and were undergraduate students at the University of Wolverhampton. Participation in the study was rewarded with course credits. Participants all had normal or corrected to normal vision.

18.2 Stimuli

Composite faces were created from the expressions of happy, sad, anger and surprise from the FEEST (York et al., 2002) stimuli set. Images of the expressions portrayed by 10 actors were cut in half across the bridge of the nose, using Photoshop. These images were then realigned to make composite images that consisted of a happy top and surprise bottom, or a surprise top and happy bottom, and the same for the expressions of anger and sadness. The images were also then made into non-composite stimuli, in which the two halves of the faces were misaligned. Examples of the composite stimuli can be seen in Figure 8.

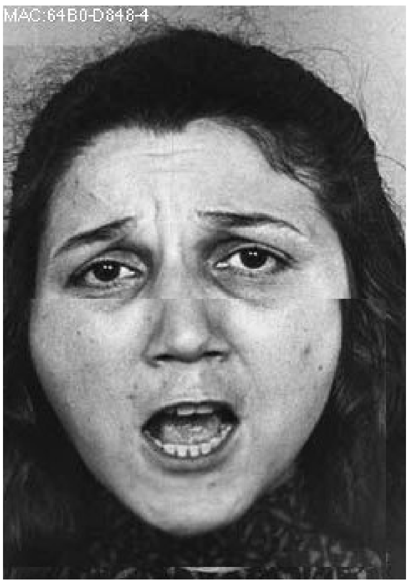

Figure 8a: sad top, angry bottom expression Figure 8b: happy top, surprise bottom expression

Figure 8. Two composite faces, one configural (Figure 8a) and one featural (Figure 8b).

18.3 Procedure

Following the procedure employed by Calder et al (2000b), the experiment began with a random presentation of 40 whole facial expressions (10 actors posing the four expressions of anger, sadness, happy and surprise) to familiarise participants with the (full) expressions they would be required to later identify. Each trial consisted of a single face presented above 4 coloured squares each with one of the emotion labels presented on it. Each colour represented one of the coloured response keys (from the number pad on the key board) and participants were instructed to press the coloured key that represented the expression they believed the faceto be displaying.

Following the familiarisation procedure participants completed the first of two experimental blocks. Half the participants completed the 'bottom-half' block first and the other half completed the 'top-half' block first. For the 'top-half' block the participants were presented with a single presentation of the 40 top halves of each expression and were asked to indicate the expression shown, to familiarise them with the half expressions. The experimental composite trials followed this. These consisted of 10 random practice trials, followed by 80 experimental trials. Each trial consisted of one composite or non-composite expression, and participants were instructed to identify the expression in the top half of the face as quickly and accurately as possible, using the response keys.

The procedure for the bottom half trials was the same as for the top half, with the only difference being the presentation of the 40 bottom halves of expressions replacing the presentation of the 40 top halves preceding the experimental trials. After completing their first experimental block, participants were given a 30 second break, followed by the second experimental block (i.e. participants who did the top-half block first completed the bottom-half block second and vice versa). Each image remained on the screen until the participant responded.

19 RESULTS

Participants' reaction time data for correct responses can be seen in Table 3 and correct recognition scores can be seen in Table 4, both for the experimental (composite) stimuli.

Table 4. Mean reaction times in milliseconds to the different experimental composite images (following log transformation)

	Identify top half of image	Identify bottom half of image
Featural composite	3.3057 sd. 0.13119	3.2544 sd. 0.12784
Featural non-composite	3.2323 sd. 0.09403	3.1964 sd. 0.09354
Configural composite	3.2606 sd. 0.11617	3.3158 sd. 0.15964
Configural non-composite	3.2174 sd. 0.10094	3.2617 sd. 0.09844

Table 5. Mean correct recognition scores for each of the experimental composite stimuli types

	Identify top half of image	Identify bottom half of image
Featural composite	11.583 (57.9%) sd. 4.115	16.333 (81.7%) sd. 3.13
Featural non-composite	16.777 (83.9%) sd. 3.252	16.527 (82.6%) sd. 3.384
Configural composite	13.833 (69.2%) sd. 3.056	11.111(56%) sd. 2.754
Configural non-composite	15.277 (76.4%) sd. 2.793	14.139 (70.7%) sd. 3.373

* Maximum score = 20

It can be seen that the recognition scores for both featural and configural composites were lower than the scores when the expressions were shown as non-composites. Thus, suggesting that participants found it more difficult to recognise the expressions when the two face halves were aligned to form a whole face configuration.

19.1 Analysis

The reaction time data was log transformed to reduce the variance in the data, remove outliers and therefore reduce any non-normality in the data. The transformed data was then submitted to a 3-way ANOVA investigating expression type (featural versus configural), stimulus type (composite versus non-composite) and task type (identify the expression in the top half or bottom half of the image).

The ANOVA revealed a significant main effect of stimulus type F (1, 35) = 30.982, $p <$ 0.0005) indicating that participants took longer to correctly recognise facial expressions when they were in composite images, compared to when they were misaligned.

There was no significant main effect of task type *F* (1, 35) =0.042, *p*= .838) or expression type *F* (1, 35) = 1.444, *p*= .238).

There was one significant interaction in the results, which was between expression type and task type, F (1, 35) = 17.538, *p* < .0005). This interaction revealed that featural expressions were identified more quickly in the 'bottom half' condition and configural expressions were identified more quickly in the 'top half' condition. This interaction can be seen in Figure 9.

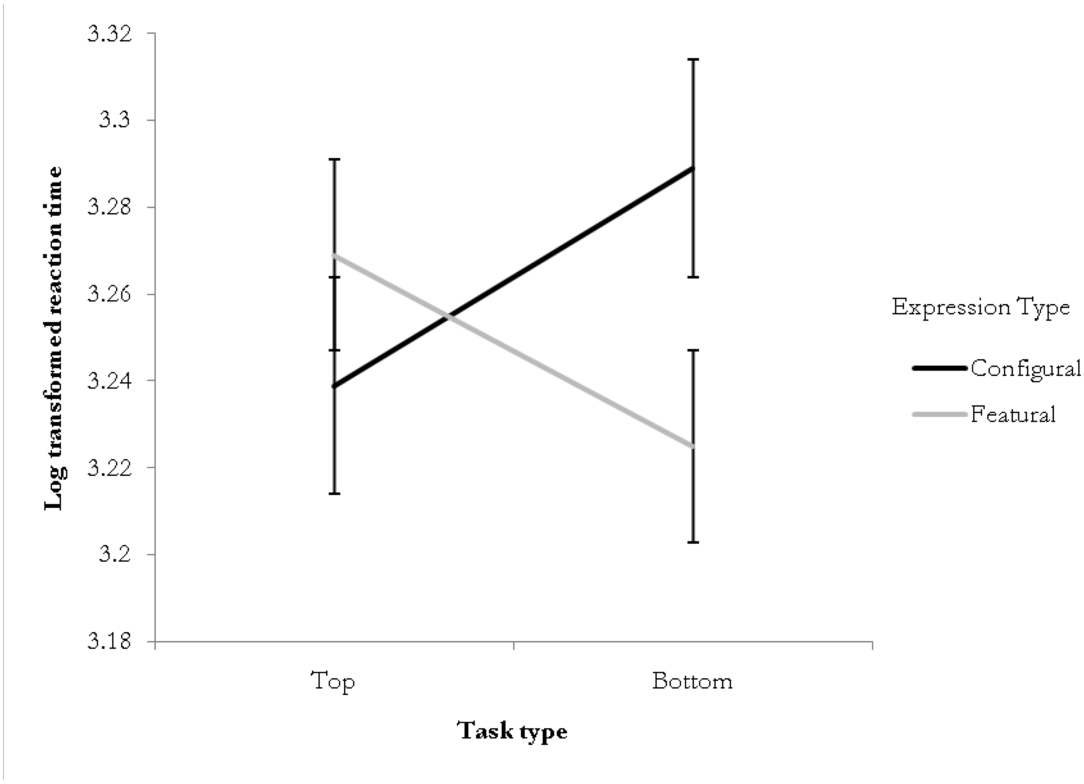

Figure 9. Participants mean correct reaction time data (after log transformation) for featural and configural expressions in both conditions of task type (identify the top half of the image or identify the bottom half of the image).

19.2 Follow up analysis

A paired sample t-test was conducted to investigate whether there was a significant difference between participant's performance with configural and featural expressions in the 'bottom-half' task; this revealed that participants were significantly faster to identify the bottom halves of featural expressions compared to configural expressions (t =3.590 df = 35, $p < 0.001$).

A paired sample t-test was also conducted to investigate whether there was a significant difference between participant's performance with configural and featural expressions in the 'top-half' task; this revealed no significant difference between participants ability to identify the expressions in the top half of an expression, regardless of whether the expression was configural or featural (t =-1.671, df = 35, p = 0.104).

20 DISCUSSION

The aim of experiment two was to investigate the composite effect for facial expressions utilising combinations of expressions previously not investigated. The experiment revealed a reliable composite effect. When two halves of different facial expressions were aligned to form a whole face, participants were slower to recognise the expression in either half than if the face halves were misaligned. The results of this experiment lend further support to the configural model for facial expression recognition. The configural model (or dual-mode hypothesis) predicts that both types of processing (configural and featural) are employed for normal face perception, and that if one mode is disrupted, encoding becomes possible via the other mode. In an unmanipulated face configural processing is the primary method employed and this makes processing of faces fast.

In the present study participants' reaction times suggest that they perceive a composite image as a whole image, and process it as such using configural encoding and information. However, because the two halves are not part of the same expression, there is interference with the configural encoding, therefore extending the decision time as participants have to then rely on featural or componential processing (following Young et al., 1987). When configural processing is not encouraged, by misaligning the face, the expressions in the two halves can be processed without interference from the perceived 'configuration' of the whole face, hence speeding up recognition time.

The present experiment reveals that the composite effect for facial expressions holds even when the expressions employed are presumed to rely primarily on featural information (McKelvie, 1995; Prkachin, 2003). Even when the expressions in the composite images were ones previously suggested as recognisable via identifiable components (i.e. happiness and surprise) the composite effect still occurred. Further, in experiment one reported in chapter two there was evidence that the expression of sadness may also be more reliant upon featural information, although previous research (McKelvie, 1995: Prkachin, 2003) suggests that this expression is configural. However, even when this expression was combined in a composite, the over-riding configural processing strategy again disrupted participants' ability to identify the expression. These findings further support the configural nature of expression perception. Even though there is some evidence that happiness, surprise and sadness are readily processed by featural strategies, when aligned with each other into a composite image, the impression of a whole face encouraged configural processing and the featural information became 'secondary'. The present experiment therefore supports the assumption that facial expressions are primarily processed configurally and that when this mode of processing is encouraged (i.e. by a 'full face' image) it is hard for participants to process featural information. This effect occurred even when the facial components included have been suggested to rely upon featural information more than configural.

Experiment three was therefore designed to further test the possibility that some facial expressions may be more reliant on featural processing compared to configural. Although the results from experiment one and experiment two suggest that the basic facial expressions of emotion are primarily processed configurally, patterns in the inversion data from experiment one suggested that the expressions of happiness and surprise were less affected by the manipulation than others, which had previously been taken as evidence that these expressions were more featural (McKelvie, 1995; Prkachin, 2003). Further, employing the Thatcher illusion in experiment one had suggested the expression of sadness benefitted from having the featural information remain upright in an otherwise inverted face, indicative of featural facilitation for the recognition of this expression. To test these findings further experiment three utilised a featural manipulation, spatial scale removal, which precludes featural processing leaving configural as the predominant strategy.

Chapter Four

SPATIAL SCALE MANIPULATION AND FACIAL EXPRESSIONS

21 ABSTRACT

The previous two studies have employed a configural manipulation to investigate what happens to the recognition of facial expressions when configural processing is disrupted. In the present experiment a featural manipulation was applied to all six of the basic facial expressions of emotion to ascertain the impact of degrading high spatial frequency information in a face, which is presumed to encode featural information. It was found that the manipulation did not significantly affect the recognition of happiness, sadness and surprise; but it did affect the recognition of anger, disgust and fear. However, all expressions were again recognised at above chance level, revealing the robust nature of facial expression perception and lending further support to the dual mode hypothesis.

22 INTRODUCTION

Research investigating the mode of processing involved with facial expressions primarily employs manipulations that disrupt configural processing or alter configural information (e.g. Thatcher illusion, inversion, composite faces) whilst leaving featural information relatively undisturbed. Therefore results have been based upon what happens or does not happen when configural processing has been precluded. Whilst this method is extremely useful and provides a valuable way of researching how facial expressions are recognised and processed, it is also important to investigate what happens to facial expression processing when only the configural mode is available.

In order to isolate configural information and the configural processing strategy it is necessary to disrupt featural information and to disrupt it a greater extent than configural information. Sergent (1986) suggested that the coarser, low spatial frequency information contained in a face encodes the configural information, whereas the high spatial frequencies in a face encode the fine detail. Such fine detail corresponds to the featural information in a face, for example, feature shape and size and individual features such as moles or distinguishing marks (Morrison and Schyns, 2001). In support of this Goffaux, Hault, Michel, Vuong & Rossion (2005) removed the high spatial frequency information in face images which had undergone either configural or featural changes. The high spatial frequency filter left only coarse grain, low spatial frequency information in the faces. It was found that the low spatial frequencies encouraged more efficient processing of the configural changes in the faces, but no benefit was found for the featural changes; therefore suggesting that removing high spatial frequencies disrupts the processing of featural information.

The high spatial frequencies can be removed by adding noise or blur to an image. Collishaw and Hole (2000) investigated the ability to identify faces which had a blur filter applied to them, thus disrupting the featural information and therefore featural processing more than any disruptions to configural processing. In order to consider the difference between featural manipulations and configural, inversion and scrambling were also employed. These authors investigated both featural and configural manipulations individually and then combined them. It was found that each of the manipulations (blurring, scrambling and inversion) disrupted recognition of identity, but recognition still remained above chance with these manipulations applied. Also a combination of the two configural manipulations (scrambling and inversion) resulted in above chance recognition. However, as would be expected, when a combination of a featural (blurring) and configural manipulation (either scrambling or inversion) was applied, recognition dropped to chance level. Collishaw and Hole suggest that this is due to the fact that when a configural manipulation is applied, thus disrupting configural processing, the featural processing strategy is still available and therefore recognition does not suffer and vice versa. When both modes of processing are disrupted recognition drops to chance level as no processing strategy can then be optimally employed.

22.1 Spatial Scale and Expressions

The effects of removing high spatial frequencies from facial expressions and therefore investigating what happens to the processing of expressions when configural information is isolated have only been researched twice. Endo, Kirita and Abe (1995) looked at the effects of blurring the facial expressions of happiness and sadness. Based on work by Kirita and Endo (1995) which suggested that happy faces are primarily processed in a configural way and sad faces are more reliant upon featural processing, Endo et al. (1995) aimed to further test these results by removing the featural mode of processing. They argued that if sad faces are more reliant upon featural processing, then the removal of high spatial frequencies should diminish participants' ability to discriminate these sad expressions, whilst the happy expression should remain unaffected as the primary mode of processing for that expression will not be disrupted. Participants were assigned to one of two conditions (happy or sad) and presented with a single face and asked whether the face was presenting a happy (or sad) expression or neutral expression. The faces were viewed with increasing levels of blur applied and their ability to discriminate the expressions was tested. It was found that discrimination accuracy between sad and neutral expressions gradually declined as the level of blur increased, as was predicted by the authors. For the happy versus neutral discrimination the accuracy level remained high until the level of blur was extremely high, at which point discrimination accuracy still remained at above chance. Therefore suggesting that discrimination of these two expressions (happiness and sadness) is reliant upon different spatial information. Happiness could be discriminated upon the basis of low spatial frequency information alone, whilst sadness required at least some higher spatial frequency information to be available. It was also found that reaction times for discriminating happy expressions were not affected by the level of blur and remained fast regardless of level of distortion. Sadness showed the opposite pattern, with increased reaction times for blurred images. The Endo, Kirita and Abe (1995) study suggests that the effects of removing high spatial frequencies from facial expression could reveal that different expressions are reliant upon configural and featural processing to different degrees; however, as these authors did not include any other expressions no general conclusions can be drawn from their investigation. One criticism of the study is the use of a discrimination task: as these tasks do not reflect naturalistic face processing their use has been criticised (Morrison and Schnys, 2001). Whilst the conclusions of the Endo et al. (1995) study are important it must also be noted that what they actually reveal about facial expressions is which spatial frequencies are important for discriminating happy or sad expressions from a neutral one.

In a recent study White and Li (2006) investigated the manipulations of blurring and pixellating on facial expressions. They employed a matching paradigm to research the ability to match both facial expressions and identity under three conditions-blurred, pixellated and unmanipulated. The Ekman and Friesen (1976) pictures of facial affect stimuli set were used for the study; however, only 4 female actresses portraying 4 facial expressions (anger, happiness, fear and sadness) were employed. White and Li reported longer response latencies for expression matches than identity matches and that expression matches were more impacted by the manipulations of blurring and pixellating than were the identity matches. It was also found that expressions were equally as affected by pixellating and blurring, with no significant differences between the two manipulations on the ability to match facial expressions. The authors acknowledge that a criticism of their study is the lack (or potential lack) of generalisability to other identities and facial expressions. Further, the investigation did not go on to assess the impact of the manipulations upon each of the individual expressions, rather it treated expressions as a homogeneous set of stimuli.

In the present study the impact of applying a featural manipulation to all six of the Ekman and Friesen (1976) basic facial expressions was investigated. Participants were required to identify which facial expression is being presented on a face, thus using a more naturalistic face processing task and therefore avoiding the criticism of employing a discrimination task which are not akin to natural processing methods. All faces were shown unmanipulated, inverted, blurred and blurred and inverted. Therefore, a baseline measure could be taken for performance with normal, unmanipulated facial expressions, with a featural manipulation (blur), a configural manipulation (inversion) and with both a featural and configural manipulation (blurred and inverted) applied.

If happiness is based primarily on configural properties (as suggested by Endo, Kirita and Abe, 1995) then a featural manipulation, such as blur, would be expected to have very little impact on the recognition of the expression. Endo, Kirita and Abe (1995) also proposed that sadness is based on featural information and processing, therefore, if this is correct, a featural manipulation would be expected to severely impact the recognition of this expression. However, other researchers have suggested an opposite pattern of results for these two expressions. McKelvie (1995) and Prkachin (2003) have both suggested that happiness is a featural expression and sadness a configural expression. To further add to the confusion surrounding these two expressions, the results of experiments in the present thesis suggest that both expressions are impacted by configural manipulations (inversion and Thatcherisation) and thus are both reliant upon configural information and processing. Whilst in experiment one, some featural facilitation was also observed fro the recognition of sadness, therefore raising the possibility that this expression may be more reliant upon featural information than configural.

Therefore, due to the conflicting and somewhat confusing results found for the influence of configural and featural processing with different expressions, the predictions for the present experiment are not specific to individual expressions. The predictions for the present study were therefore that an inversion effect (i.e. reduced accuracy at identifying expressions is found when faces are inverted) would be found for all 6 of the unmanipulated facial expressions. Further it was predicted that the featural manipulation of blurring would reduce the recognition accuracy of facial expressions, although this impact may potentially be greater for some expressions than others (due to conflicting past research no specific predictions are being made). Further, it was predicted that the combined configural (inversion) and featural (blurring) manipulations would reduce recognition accuracy to a greater extent than either type of manipulation when applied in isolation.

23 METHOD

23.1 Participants

Sixty four participants took part in the study, 55 females and 9 males. All participants were in the age range of 18 to 50 years old and were undergraduate students at the University of Wolverhampton. Participants were randomly allocated to one of four conditions. Participation in the study was rewarded with course credits. Participants all had normal or corrected to normal vision.

23.2 Stimuli

Facial expression stimuli were taken from the FEEST program (York et al., 2002). In total 60 faces were employed (10 actors portraying 6 emotional facial expressions of anger, disgust, fear, happiness, sadness and surprise). The images were all the same size and resolution (241 x 362 pixels). These faces were then manipulated to provide stimuli for each of the four conditions of the experiment (1) normal upright, (2) normal inverted, (3) blur, (4) blur + inverted.

Four versions of each face were created for use in the four experimental conditions. All of the manipulated stimuli were prepared using Adobe Photoshop 5.0 LE. Normal upright faces remained unmanipulated. The inverted faces were rotated through 180 degrees and re-sized to match the original images. The manipulation of blur was applied using in-built filters in Photoshop. A Gaussian filter of radius 10 pixels was employed to blur the images (following Collishaw and Hole, 2000). The blur versions of each face were then inverted following the same procedure as the normal inverted faces to create the blur + inverted versions. Examples of the stimuli used can be seen in Figure 10.

Stimuli were then presented using SuperLab Pro (version 1.75). The pictures of the faces appeared above six coloured squares; these indicated the response keys for participants. Super Lab then recorded participants' responses and reaction time. Two versions of the experiment were created, so that control faces were not the same as experimental faces. In version one therefore female actresses 2, 4 and 6 and male actors 4 and 6 were the control faces and females 4, 5 and 8 and males 1 and 5 were the experimental actors. In the second version this order was reversed. Participants in each experimental condition (1) normal upright, (2) normal inverted, (3) blur, (4) blur +

inverted, were therefore randomly allocated to either version one or two of the experiment.

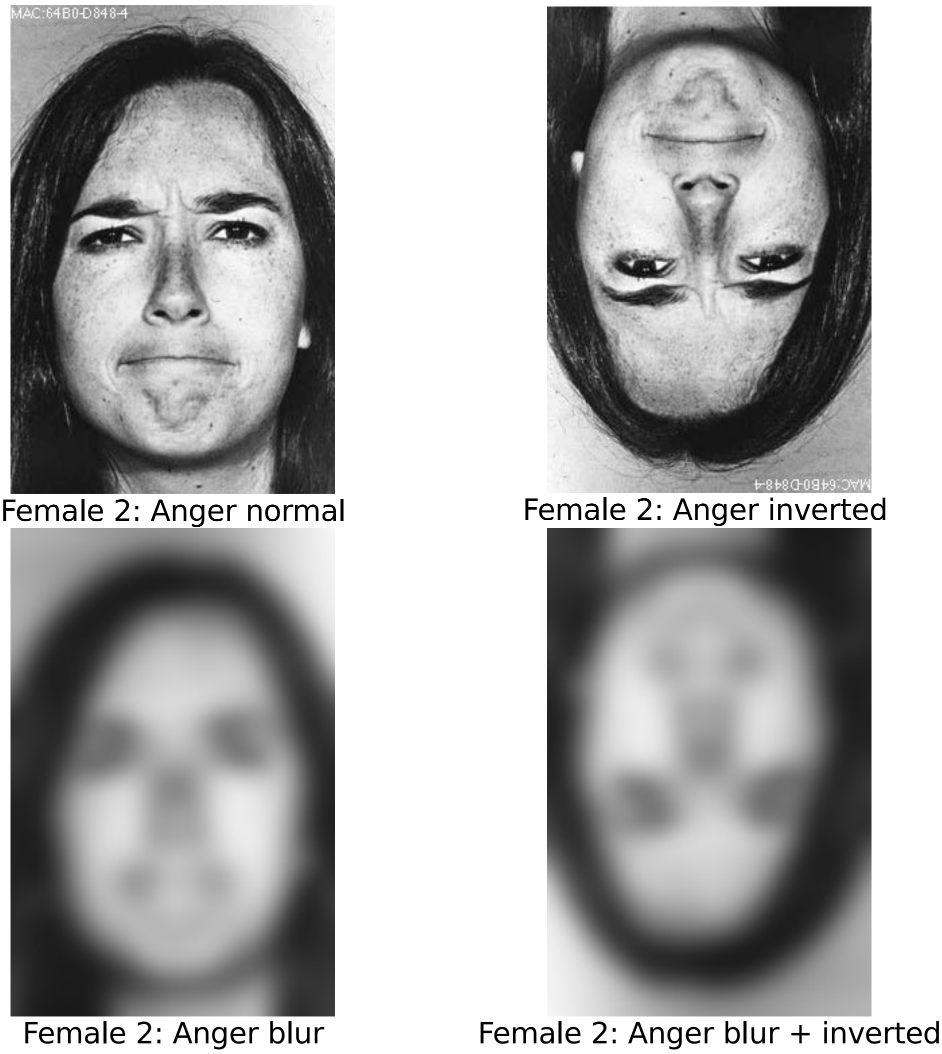

Figure 10. Examples of each of the four experimental manipulations employed for this experiment. Each picture represents the Ekman and Friesen (1976) actor (Female 2) portraying the facial expression of anger.

23.3 Procedure

Each experiment consisted of two blocks of trials, with 30 stimuli in each block. The experiment began with standardised instructions being issued to each participant. The first block of trials consisted of unmanipulated control faces. At the end of the control block participants were issued with an instruction screen indicating that the task would remain the same and practice trials were to follow. The 10 practice trials had been randomly chosen from the experimental trials and followed the same presentation format as the control faces. Following the practice trials the experimental block was presented in the same manner. The order of stimuli presentation within each block was randomised for each participant.

The participants' task was to indicate which of the six facial expressions they thought a face was portraying. Participants were instructed to respond to each face as quickly and as accurately as possible. Each trial consisted of the presentation of a face above 6 coloured squares. On each square an expression label was presented and these corresponded to the participants' response keys that were located on the number pad to the right of the keyboard. Each face was presented for a maximum of 3 seconds or until a response was made, after which a blank inter stimulus screen was presented for 3 seconds.

24 RESULTS

Accuracy scores were collected for this study by counting the number of correctly identified expressions for each participant. Correct recognition of the expressions was defined as recognition of the original expression shown on the face, regardless of manipulation applied. In Table 6 displays participants log transformed reaction times to make a correct recognition score, along with the standard deviations, for each of the four conditions. In Table 7 participants' mean correct recognition scores and standard deviations are presented for each of the four conditions. Figure 11 illustrates the percentage correct recognition for each of the 4 manipulations employed, in comparison to participants' performance with unmanipulated faces.

Table 6: Reaction times (following log transformation) for participants to make a correct recognition decision in each of the four experimental conditions.

Condition	Normal	Inverted	Blur	Blur + Inverted
Mean SD	3.161 (0.0605)	3.1691 (0.0438)	3.1725 (0.0591)	3.2031 (0.0807)

As can be seen in Table 6, there was very little variation in reaction times to expressions when each of the manipulations had been applied. As would be expected, the configural (inverted) and featural (blurred) manipulations applied together elicited the longest reaction time latencies.

Table 7. Mean correct recognition scores for each of the four conditions.

Condition	Normal	Inverted	Blur	Blur + Inverted
Mean SD	23.75 (3.276)	18.12 (3.828)	16.81 (3.103)	12.50 (2.683)

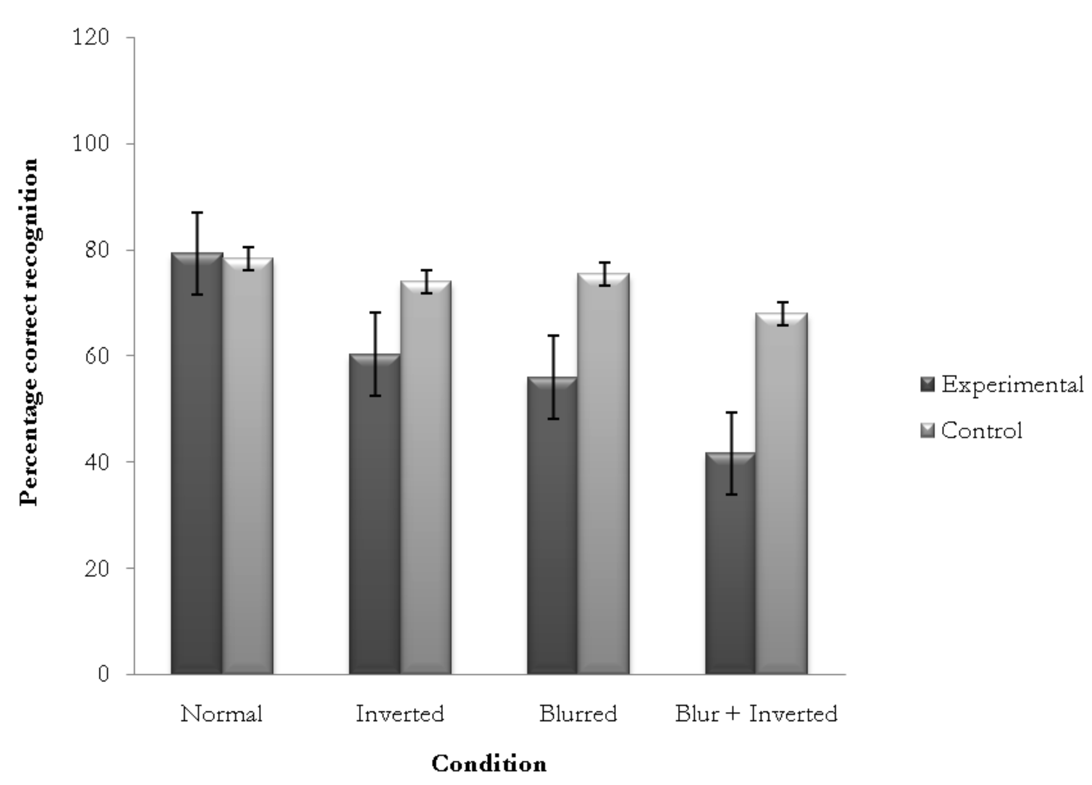

Figure 11. The effects of inversion, blurring and blurring + inversion on the recognition of facial expressions of emotion.

24.1 Analyses

The correct score results were analysed using one way analysis of variance to investigate the effect of condition, with the Tukey HSD test being employed for follow up analyses. The analysis revealed that there was a highly significant main effect of condition on the participants' ability to recognise facial expressions of emotion with the experimental faces ($F_{3, 60} = 32.634$, $p < 0.0005$). The specific pattern of results revealed by the Tukey tests is that normal faces were recognised with the greatest accuracy ($p < 0.0005$) and that blurred ($p < 0.0005$) and inverted ($p < 0.0005$) faces were recognised with more accuracy than faces that were both blurred and inverted. However, there was no significant difference between blurred faces and inverted faces (p = 0.665).

A one way analysis of variance was also conducted on participants' performance with the control faces, to ascertain whether there were differences between the groups of participants on these faces. This analysis revealed no significant main effect of condition ($F_{3, 60} = 2.377$, $p = 0.079$).

Reaction times were also analysed using a one way analysis of variance, this revealed no significant main effect of condition ($F_{3, 60} = 1.382$, $p = 0.257$).

24.1.1 Individual Facial Expressions

One way within subjects analyses of variance were conducted for each of the four manipulations to compare recognition of the six facial expressions of emotion.

24.1.1.1 Inversion

As can be seen in Figure 12 there was an inversion effect for anger ($p < 0.005$), disgust ($p < 0.005$), fear ($p < 0.01$), sadness ($p < 0.005$) and surprise ($p < 0.05$), however, happiness was not affected by inversion ($p = 0.333$).

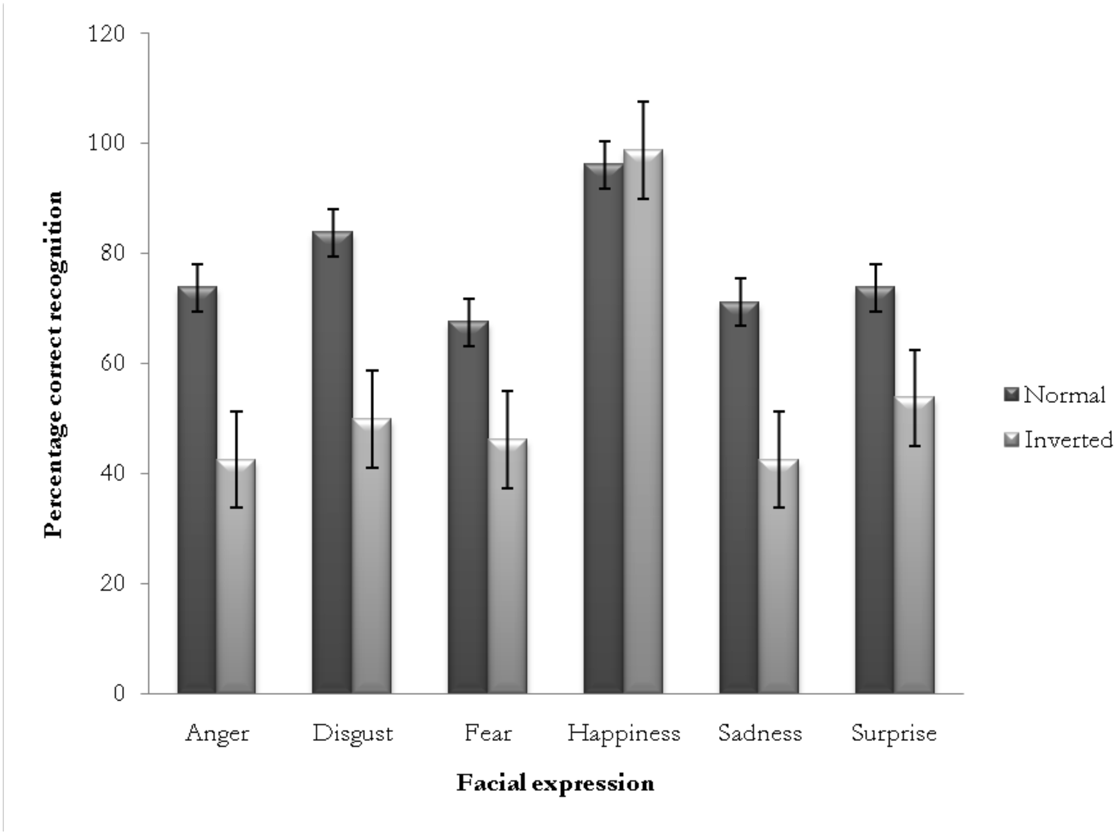

Figure 12. Percentage correct recognition of each facial expression when viewed upright and inverted.

24.1.1.2Blur

Blur significantly affected the expressions of anger ($p < 0.0005$), disgust ($p <0.0005$), and fear ($p< 0.01$). However, there was no significant effect of blur on the expressions of happiness ($p= 0.333$), sadness ($p= 0.276$), and surprise ($p= 0.085$). The pattem of results can be seen in Figure 13.

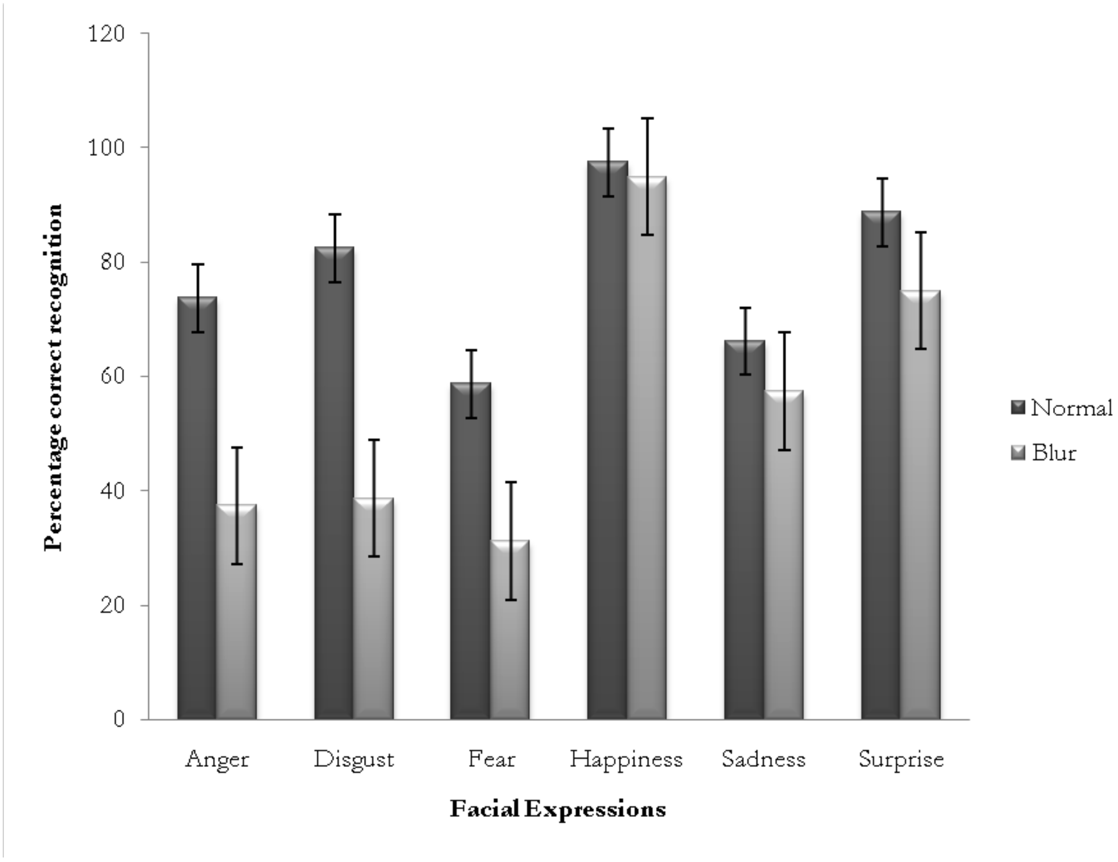

Figure 13. Correct recognition of facial expressions of emotion whilst blurred

24.1.1.3Blurred + inverted

As can be seen in Figure 14, combining the manipulations of blur and inversion produced a significant effect for all expressions other than happiness (Anger ($p< 0.01$), disgust ($p< 0.005$), fear ($p< 0.005$), sad ($p< 0.005$), and surprise ($p < 0.0005$); Happiness ($p= 0.216$).

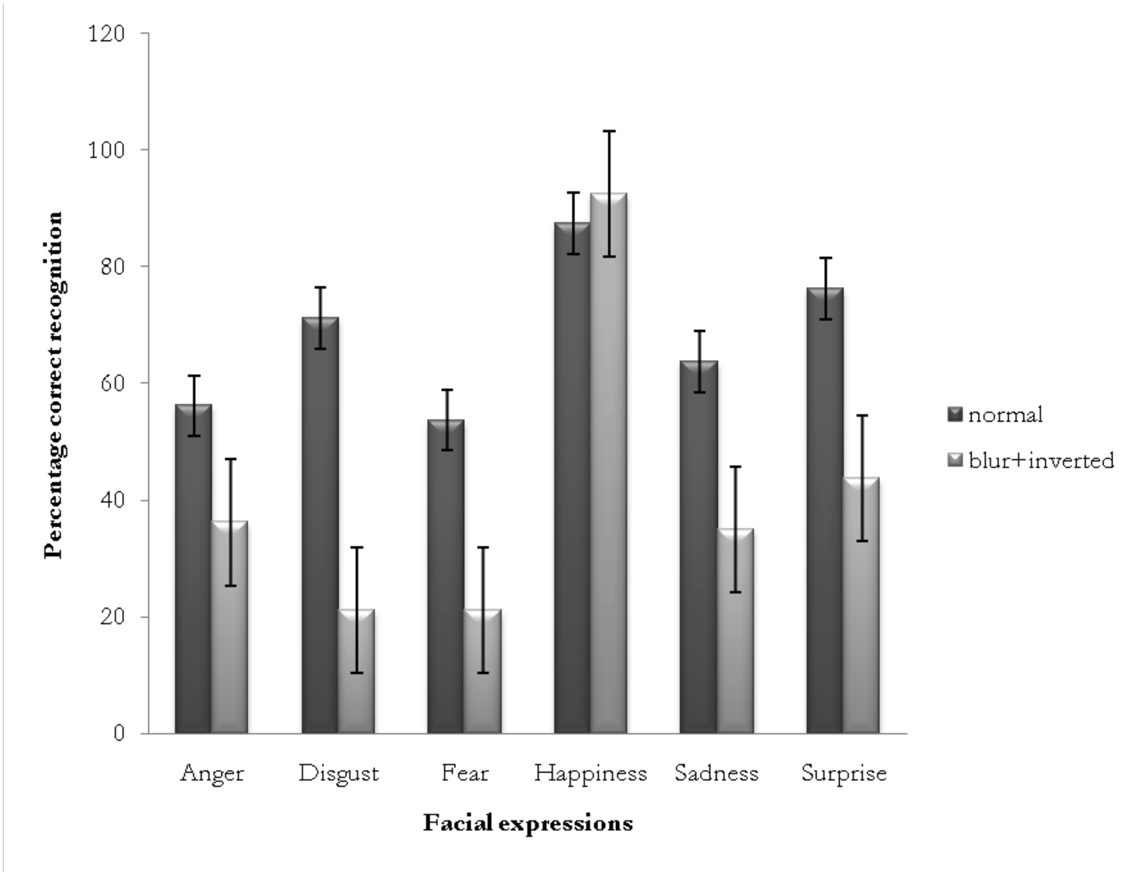

Figure 14. Percentage correct recognition scores for each expression when blur + inversion were applied.

25 DISCUSSION

The majority of research on the configural and featural processing of facial expressions and facial identity employs configural manipulations and then extrapolates what happens when only featural information or very impoverished configural information remains in the face. By utilising a featural manipulation experiment three was able to investigate the processing of facial expressions of emotion when featural information and processing has been precluded and only configural information remains in a face. Experiment three therefore investigated the impact of both a configural manipulation (inversion) and a featural manipulation (blurring) upon the recognition of facial expressions of emotion, as well as the combined effect of these two types of manipulation (blurring and inverting a face). It was found that participants' accuracy at recognising five of the six basic facial expressions of emotion (anger, disgust, fear, sadness and surprise) was disrupted when either a configural or featural manipulation was applied to the expression. This therefore suggests that both types of manipulation disrupt important information for the processing and recognition of facial expressions.

As predicted by previous research (Bartlett & Searcy, 1993; Fallshore & Bartholow, 2003; McKelvie, 1995; Muskat & Sjoberg, 2000; Prkachin, 2003; White, 1999) and the first experiment presented in this thesis, there was a significant inversion effect found for the majority of the facial expressions. All of the expressions, other than happiness, were recognised with reduced accuracy when inverted. This therefore suggests that recognition of all six of the basic facial expressions of emotion is significantly reliant upon configural processing strategies; although happiness can also be recognised when configural information has been largely disrupted. This discrepancy with the expression of happiness seems to reflect the unique nature of this facial expression (see, Feyereisen, Malet & Martin, 1986; Kirita & Endo, 1995).

The manipulation of blurring also impacted upon the recognition of facial expressions of emotion. Applying a blur filter to the expressions reduced the accuracy with which all 6 of the emotions were recognised;

however, only the recognition of anger, disgust and fear was significantly reduced. The expressions of happiness, sadness and surprise were not significantly affected by the disruption of featural information. This therefore would suggest that the recognition of anger, disgust and fear in the present experiment was severely impacted when only coarse, configural information was available; and was therefore affected by featural manipulations. Again, however, even with the blur filter applied, each of the expressions was recognised with above chance accuracy suggesting that with severely featurally degraded stimuli, expressions can still be recognised. As mentioned in the discussion for experiment one (page 76) it is difficult to estimate chance recognition for the expressions in this experiment. If each expression had an equal chance of being chosen at random then chance performance would be 18%, however, the unique results found with happiness make this calculation difficult. The expression of happiness is nearly always recognised at near ceiling levels and therefore it may be necessary to remove this expression from the chance equation, making chance performance nearer to the 20% level. Again, however, as in experiment one in the current thesis, performance remains above this level under all manipulations for all six of the expressions.

It is also interesting to note that there is some variation in participants' performance with the unmanipulated versions of each expression when comparing across the three manipulations (inversion, blur and blur + inversion). This may suggest that there were inherent systematic differences between participants in the different groups. In previous research McKelvie (1995) found different patterns of inversion effects across the six basic facial expressions of emotion when employing a between subjects design and a within subjects one. Therefore, it is possible that if this experiment had been conducted as a within subjects design, these differences between performance on unmanipulated expressions may not have been observed. Of course, altering the design would have made a comparison with the original research (Collishaw and Hole, 2000) more difficult.

26 SUMMARY

The results of the present study therefore again found a reliable inversion effect suggesting that all of the expressions are impacted by configural manipulations. However, in this experiment the recognition of the expression of happiness was not significantly reduced (in fact it increased with inversion) suggesting that happiness can be identified and recognised regardless of which type of manipulation is applied to it. With the manipulation of blur applied to the expressions, it was found that by removing featural information from a face there was no significant impact on happiness, sadness and surprise. This suggests that these three expressions are all primarily configurally based expressions which are not affected by applying the featural manipulation. However, an interesting result was that the recognition of anger, disgust and fear were all significantly reduced when the featural manipulation was applied, indicative of these expressions requiring featural information to be recognised. In previous experiments in this thesis the expressions of anger, disgust and fear have been impacted by configural manipulations, suggesting that this processing strategy is extremely important for their recognition. However, in experiment one disgust and fear were recognised with more accuracy when there was featural facilitation (in the Thatcher inverted condition compared to normal inverted) again, indicative of these expressions being more featural based. The impact of both configural and featural manipulations on these expressions would suggest that they are reliant on a combination of both featural and configural information being present in a face for them to be recognised.

The next two experiments in the series move the investigation on to look at whether differences occur between the six expressions based on which type of configural processing is disrupted. So far, the evidence compiled by the present thesis suggests that all six of the basic facial expressions are highly reliant upon configural processing, with small differences occurring for some expressions depending on the manipulation employed. However, no strong, consistent evidence has been found that the expressions of happiness and surprise are more featural than configural, conflicting with some previous research (McKelvie, 1995; Prkachin, 2003). Although, there is some evidence to suggest that disgust and fear may be more reliant upon featural, or equally as reliant upon both processing strategies. Therefore, experiments four and five were designed to investigate whether the differences found could be based on the type of configural information (rather than a configural/featural divide) and therefore processing, being employed with the different facial expressions.

Chapter Five

FIRST AND SECOND ORDER CONFIGURAL INFLUENCES ON FACIAL EXPRESSIONS

27 ABSTRACT

Two experiments which investigate the impact of first order and second order configural manipulations are presented in this chapter. Previous research (White, 2002) had suggested that facial expression processing was more affected by manipulations which disrupted first order information in a face compared to second order manipulations. Experiment four was a replication of the study by White (2002) and found no evidence of a difference between applying a first order and a second order manipulation on the matching of facial expressions. Experiment five examined the ability to recognise each of the six basic expressions under the manipulations. Again, no evidence that facial expressions are more reliant upon first order configural information was found.

28 INTRODUCTION

The evidence so far gathered in this thesis on the recognition of facial expressions suggests that as stimuli per se, facial expressions are processed and recognised configurally. However, when examining the individual patterns of effects for each expression the picture is not so clear. Whilst the recognition of all six of the basic expressions is reduced by the robust configural manipulation of inversion, the recognition of three expressions was impacted by applying a featural manipulation. The three expressions affected by removing the featural information were anger, disgust and fear, which had not previously been reported as reliant upon featural information in the literature. In the present thesis however, the expressions of disgust and fear have been found to be recognised better in inverted faces that had upright features (inverted Thatcher faces, experiment one) than inverted faces which had inverted features, suggesting some facilitative effect of featural information for these expressions. In experiment two, using the composite effect, it was found that happiness and surprise expressions, which had previously been suggested to be reliant upon featural information (McKelvie, 1995; Prkachin, 2003), were still subject to the composite effect. This meant that even with expressions which were thought to be recognised by single, identifiable features; configural processing was dominant enough to for the recognition of these features to be over-ridden. The composite effect also held with the expression of sadness and anger, which the current research had found some evidence for being featural (experiment one and experiment three). Thus it follows that all expressions are highly reliant upon configural processing and this is the primary processing strategy for all six of the expressions. However, under manipulations which impact upon either configural or featural information, different patterns of results emerge. One possibility for these effects is that although all six expressions are primarily processed configurally, this processing may be mediated by different types of configural strategies.

Numerous strands of research have suggested that the processing of facial identity is dissociable from that of facial expressions. One of the most compelling demonstrations of this comes from the clinical neuropsychology literature. People who have the condition of prosopagnosia have problems identifying familiar individuals (whether famous or personally familiar e.g. family members) and yet have no impairments in the recognition of emotion in faces (Hécaen & Angelergues, 1962). Conversely, patients who have suffered brain trauma which damages their amygdala, particularly when lesions are evident, show significant problems with recognising facial expressions of emotion whilst maintaining normal facial identity recognition (Etcoff, 1984; Tranel, Damasio & Damasio, 1988). If the processing of expressions and identity is dissociable then it makes sense that the processing strategies which mediate these two forms of recognition may be different. Therefore, research has begun to emerge which compares the configural processing of identity and expressions.

Previous research has suggested that facial expressions are akin to basic level object processing, which uses categorical representations, whereas facial identity is based on coordinate representations (Cooper & Wojan, 2000). White (2000) investigated this claim by assessing the impact of a first order (categorical) manipulation and a second order (coordinate) manipulation on the matching of expressions and identities. White proposed that facial expressions are more reliant on first order processing and identities are more reliant on second order. First order processing is the processing of the common configuration in all faces, i.e. two horizontally aligned eyes, above a centrally placed nose, above a mouth and so on. Whereas second order processing is more specific to each face, consisting of the interrelations and distances between the face features, for example, the interocular distance between the eyes, the distance between the bridge of the nose and the pupil and so on.

So far however, there has only been the one research attempt to establish whether facial expressions and facial identity do employ different configural processing strategies, and whether the processing strategy which mediates facial expressions is first or second order processing (White, 2000). White found that when a second order manipulation was applied to faces, response latencies for matching the identity in these faces was much longer than if a first order manipulation was applied. For expressions the pattern was reversed, with first order manipulations increasing participants' reaction times. Again, however, only four facial expressions of emotion (anger, fear, happy and sad) and four actors were used in the study, but the results are generalised to expression perception per se with no consideration given to whether all expressions are processed in this way, or whether there are different strategies for different expressions. This is an issue that occurs in a number of facial expression studies and needs to be addressed. As data from the present thesis suggests that considering each individual expression is an important consideration with expression research, it is possible that omitting individual expressions from research could impact on the findings

29 EXPERIMENT FOUR

The aim of experiment four was therefore to re-examine the effects of first order and second order configural manipulations on the perceptual encoding of facial expressions of emotion. By replicating the White (2000) study a direct comparison between the studies could be conducted. The present experiment also rectifies the problem of missing facial expressions and employs all six of the basic facial expressions of emotion. Based on the data from the 2002 study (White) it was expected that facial expression matching would be more impacted by a manipulation which disrupts first order configural processing than one which disrupts second order configural processing, with this pattern being reversed for identity matching.

29.1 Method

29.1.1 Participants

Forty-one participants took part in the study, 29 females and 12 males. All participants were in the age range of 18 to 46 years old and were undergraduate students at the University of Wolverhampton. Participation in the study was rewarded with course credits. Participants all had normal or corrected to normal vision.

29.1.2 Stimuli

All stimuli were taken from the FEEST program (York et al., 2002). Pictures of six female actors portraying the six basic facial expressions of emotion (anger, disgust, fear, happiness, sadness and surprise) were employed. The faces were manipulated using Adobe Photoshop 5.0 LE to create one-eye moved and two-eye moved versions of each face as well as the original no-eye moved versions (see Figure 15 for examples). In the one-eye moved stimuli, one eye was moved upwards into the forehead region by 10% of the face width. The blank area left by moving the eye was then filled in by cloning skin cells from the surrounding face area in the picture; this therefore created pictures which were as seamless as possible. For the two-eyes moved versions the same technique was employed to move both eyes.

Faces were then presented in pairs, horizontally aligned on the screen. In total 432 face pairs were created, of these 144 were normal unaltered face pairs, 144 were one-eye moved pairs (where one unaltered face was paired with a one-eye moved face) and 144 were two-eyes moved pairs (an unaltered face paired with a two-eyes moved face). For each set of 144 stimuli 36 pairs consisted of faces of the same woman portraying the same expression, 36 pairs were the same woman portraying different expressions, 36 were different women portraying different expressions and 36 were different women portraying the same expressions.

For the same women same expression pairs, every woman was paired with herself 6 times, once for each facial expression. For the other three sets of 36 pairs, the face pairs were chosen at random from the complete list of possible combinations. Once the face pair combinations had been chosen, a random number generator was employed to determine which of the two faces would be manipulated in each pair. For the one-eye moved pairs randomisation was also employed to decide whether the left or right eye would be moved.

Figure 15a   Figure 15b   Figure 15c

Figure 15. Pictures of one female portraying the emotional expression of disgust with one-eye moved (Figure 12a), unmanipulated (Figure 12b) and two-eyes moved (Figure 12c).

29.1.3 Procedure

Presentation of the 432 experimental face pairs was broken down into three experimental blocks of 144 stimuli. In each block there were 48 unaltered face pairs, 48 one-eye moved pairs and 48 two-eye moved pairs. Within these pairings the actor/expression combinations were as follows: 12 same women same expression pairs, 12 same women different expressions, 12 different women different expressions and 12 different women same expression pairs. 12 face pairs were chosen at random to become practice trials. Between each experimental block participants were given a 30 second inter-stimulus break.

Participants were randomly allocated to one of two conditions- expression matching or identity matching. 21 participants took part in the expression matching task and 20 in the identity matching task. Participants were asked to press one key if they thought the expressions/identities on the two faces were the same and another key if the expressions/identities were different.

Each trial consisted of the presentation of a pair of faces under which was the experimental question e.g. 'are the expressions the same?' The face pair and question were directly above two coloured squares. On one square was 'yes' and on the other 'no'. The colour of these squares corresponded to the colour for the response keys. This reduced any memory component for the response keys.

Participants were instructed to ignore the 'not tested' variable in the pictures i.e. participants in the identity condition were told to ignore the expressions shown by the women and vice versa. It was also made clear to the participants that on half of the trials these 'to be ignored' factors (i.e. expression and identity) would be the same and in half the trials they would be different.

Stimuli were displayed for 3 seconds and were followed by a blank screen for 2 seconds before the next trial began. Participants were asked to respond as quickly and as accurately as possible. The experiment began with a short practice session which was followed by the first experimental block, then a 30 second break followed by the second experimental block and a further break before the final block of trials. No feedback was given during the experiment.

29.2 Results

Participants' reaction time data (log transformed) to correct matches is displayed in Figure 16. The graph shows that expression matches were slower with one eye moved pairs and identity matches were slower with two eye moved pairs. The data were log transformed and analysed. Accuracy data can also be seen in Table 8.

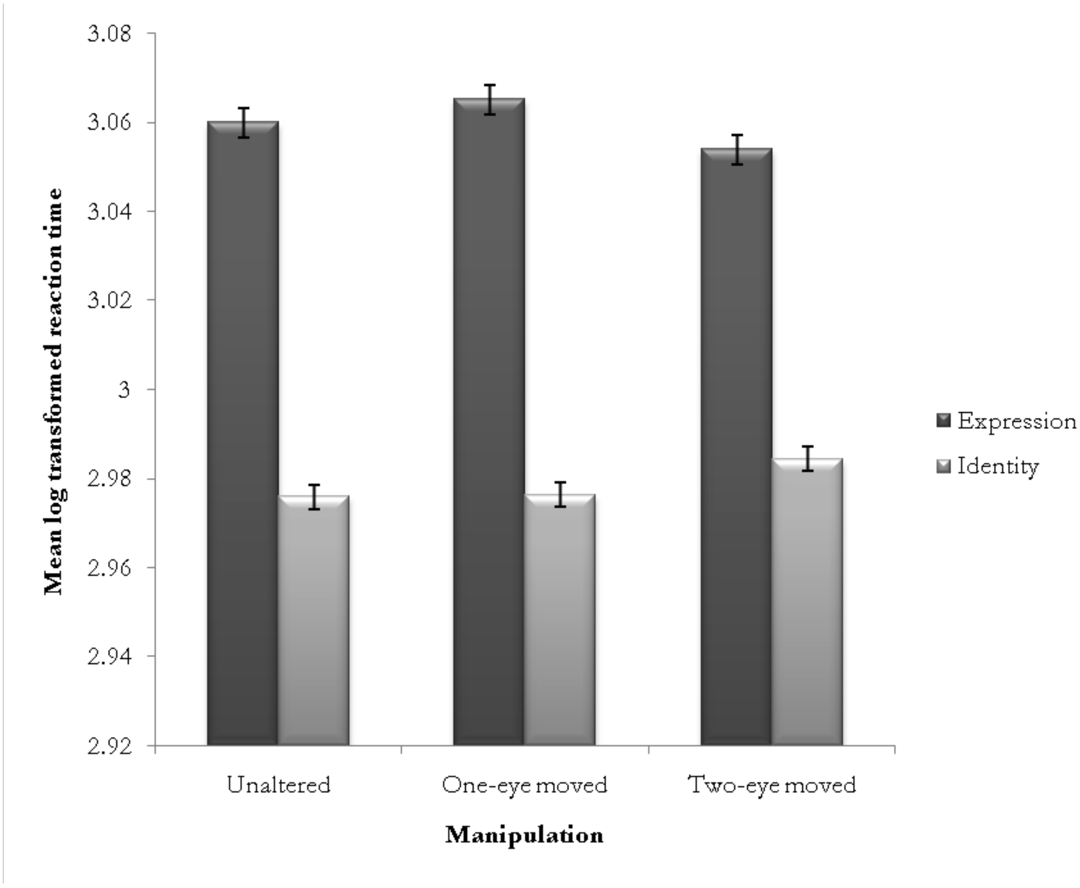

Figure 16. Mean reaction time data for identity and expression matches under the three experimental conditions

Table 8: Correct recognition scores for expression and identity matches in each of the three experimental manipulations.

	Unmanipulated	**One-eye moved**	**Two-eye moved**
Expression Matches	127.67 (sd. 3.454)	125.10 (sd. 3.727)	124.71 (sd. 4.703)
Identity Matches	135.85 (sd. 2.159)	133.60 (sd.3.440)	133.40 (sd. 2.624)

The accuracy data indicated that unmanipulated stimuli (both expressions and identities) were recognised with the highest accuracy and two eye moved faces were the least well recognised for both.

29.2.1Analyses

Correct response reaction time data was analysed using a two-way analysis of variance, having the form condition (expression matching, identity matching) x eye change (unaltered, 1 eye moved, 2 eyes moved). This ANOVA revealed a significant effect of condition ($F_{(1, 39)}$ = 10.685, *p* = .002) showing that reaction latencies for expression matches were longer than for identity matches (expression matches = 1162.397 identity matches = 970.774). No significant effect of eye change was found ($F_{(2, 78)}$ = 0.696, *p* = .502) revealing that there was no impact of expression or identity matching based on which manipulation was employed.

A significant interaction between eye change and condition ($F_{(2, 78)}$ = 7.845, *p* = .001) also revealed that expression matches took longer with one eye moved stimuli than with two eye moved (1172.678 ms and 1149.751ms), compared to identity matches where latencies were longer with two eye moved stimuli than with one eye moved (982.297ms and 966.392ms).

29.2.1.1Planned Comparisons

Planned comparisons were conducted on the expression matching and identity matching data to investigate the significance of the differences.

For identity, there was no significant difference between latencies for one eye and two eyes moved pairs (*t* =0.502 df = 19, *p* =0.621).

For expression matches, there was no significant difference between one-eye moved and two-eyes moved (t =1.290 df = 20, p =0.212) although the pattern of data is in the expected direction (one eye pairs elicited longer latencies than two eye moved pairs).

29.3 Discussion

The primary aim of experiment four was to replicate and extend the experiment conducted by White (2002) to compare the impact of first and second order configural manipulations on facial identity matching and facial expression matching. By including all 6 of the basic facial expressions of emotion the current experiment built upon White's research and provides a thorough investigation of the first/second order influence on the matching of facial expressions of emotion.

It was found that, in agreement with White (2002), facial expressions of emotion did elicit longer latencies than facial identity. The time taken for participants to match facial expressions (1162.397 ms) was significantly longer than the time taken for them to match facial identities (970.774ms). Thus suggesting that the processing of emotional expressions is more difficult than the matching of facial identities; however, this could potentially be an artefact of the pictures, where participants could be matching pictures rather than identities. For example, only one female has blonde hair, so when matching identities participants could match hair colour for this actress, thus making the task easier and response times quicker. This would not happen in the expression condition as matching hair colour or other picture artefacts would not indicate whether the two expressions were the same or not.

Previously White (2000) had claimed to have provided direct evidence that facial expression processing is more reliant upon first order configural information than is identity matching, which is more reliant upon second order configural processing. In the present study (experiment four) a replication of the interaction reported by White was found, preliminarily suggesting that his conclusions were supported. However, follow up analyses indicated that this was not the case. No direct evidence was found for facial identity matches being more disrupted by a second order manipulation than a first order one and the effect for expression matches was not significant either. Therefore, it cannot be concluded from experiment four that expression recognition matches rely more on first order configural processing than second order processing. Although the difference was extremely close to significant and the pattern of data was in the hypothesised direction i.e. with expression taking longer to match when a first order manipulation had been applied, compared to a second order one.

It is possible that this null effect has occurred due to the different facial expressions (anger, disgust, fear, happiness, sadness and surprise) being reliant upon first order and second order information to different degrees. This could therefore impact the data in an overall analysis where the data from the different expressions is considered together as ‘expression recognition’ as any differences between the expressions and their reliance upon the two types of configural data may be balanced out. Experiment five was designed to address this possibility. Experiment five also investigated the null effect of manipulation found in the present experiment. This suggests that response time latencies to matching facial identity and facial expression are not impacted by the first and second order manipulations applied. This could indicate that the matching paradigm used is not sensitive to the configural manipulations employed; therefore experiment five was also designed to assess the impact of the manipulations using a different task.

Finally, whilst experiment four provided an extension and replication of the original White (2000) study, there is further potential for the research to be expanded. In previous research (McKelvie, 1995) it has been found that between subjects designs may mask or alter observed effects. McKelvie had found different inversion effects for some of the six basic facial expressions of emotion when he conducted a study using a between subjects design, compared to a within subjects design. He concluded that potential differences between the groups of participants in the between design may have accounted for this difference. Therefore, there is scope and potential for the present experiment to be conducted utilising a completely repeated measures design to rule out any participant differences and to also make the study more comparable with the majority of the other studies conducted on facial expressions.

30 EXPERIMENT FIVE

As already discussed and acknowledged throughout the thesis it is important to consider each of the six facial expressions of emotion when drawing conclusions based on expression research. Therefore experiment five provides an investigation of the impact of first and second order manipulations on each of the six basic facial expressions of emotion. A recognition task was employed in this experiment to assess participants' ability to recognise each of the six basic expressions when first and second order manipulations had been applied and to assess the impact of using a different task (i.e. not a matching task) to investigate the impact of first and second order manipulations.

Based on the original study conducted by White (2000) it would be expected that facial expression recognition would be reduced and slower in faces which had the first order (one-eye moved) manipulation applied compared to faces with the second order manipulation applied (two-eyes moved). However, the results of experiment four provided no support for this hypothesis. In experiment four no significant difference between unmanipulated, one eye moved and two eyes moved faces was found in the expression matching task; suggesting that facial expressions are not more reliant upon first order configural processing than second order processing. The null effect of manipulation found in experiment four suggests that the manipulations may have no effect on expression recognition, and certainly no differential effect upon it.

Although much research has investigated the impact of configural manipulations on facial expression recognition, this is the first experiment which has applied the 'eye displacement' technique to a recognition experiment. Therefore, no specific predictions are made regarding the impact of the eye displacement technique upon each of the individual facial expressions.

30.1 Method

30.1.1 Participants

Forty participants took part in the study, 29 females and 11 males. All participants were in the age range of 18 to 40 years old and were undergraduate students at the University of Wolverhampton. Participation in the study was rewarded with course credits. Participants all had normal or corrected to normal vision.

30.1.2 Stimuli

The stimuli were created in the same way as for experiment four. The 36 unmanipulated facial expression pictures (6 actors each portraying 6 facial expressions of emotion) were each manipulated to create a two-eye displacement version and two one-eye versions (left eye moved and right eye moved). In total this created 144 stimuli (36 unmanipulated, 36 two-eye moved, 36 left-eye moved and 36 right-eye moved).

30.1.3 Procedure

Participants were tested in individual sessions. Standardised instructions were read out to each participant before the experiment began. These informed participants that their task was to decide which of six facial expressions of emotion an actress was portraying.

Each trial consisted of the presentation of one face, below which were 6 coloured squares which represented the response keys and were in the same configuration as the response keys. The expression names were displayed on the coloured squares on the screen. These were present on every trial and did not change; therefore attempting to minimise the required memory component for the response keys.

The experiment began with an instruction screen, which was followed by 12 practice trials. A further instruction screen reminding the participants of the task followed the practice trials and indicated the experimental trials would begin. In total 144 experimental trials were shown. 36 trials were unmanipulated versions of the 6 facial expressions, 36 were the two-eye manipulation and the remaining 72 depicted the one-eye moved manipulation (36 left eye moved and 36 right eye moved). On each trial the face was displayed until the participant responded and then a blank screen was displayed for one second. Participants were instructed to respond as quickly and accurately as possible. Both reaction time (ms) and accuracy were recorded for each trial.

30.2 Results

Accuracy scores were collected for this study by counting the number of correctly identified expressions for each participant. Correct recognition of the expressions was defined as recognition of the original expression shown on the face, regardless of manipulation applied. The time taken to make correct a recognition response was also recorded. The reaction time data were log transformed before analysis.

30.2.1 Analyses

30.2.1.1 Accuracy

Correct recognition scores were subject to a two way analysis of variance, with the form expression (anger, disgust, fear, happiness, sadness and surprise) by manipulation (unmanipulated, one eye moved, and two eyes moved).

A significant effect of expression was found ($F_{(5, 195)} = 20.399$, $p < .0005$), showing that happiness was recognised with the highest accuracy and fear the lowest, replicating data from all the other experiments in the thesis. No significant effect of manipulation ($F_{(2, 78)} = 1.426$, $p = .246$) and no significant interaction between expression and manipulation were found ($F_{(10, 390)} = 1.337$, $p = .208$). This pattern of results can be seen in Figure 17.

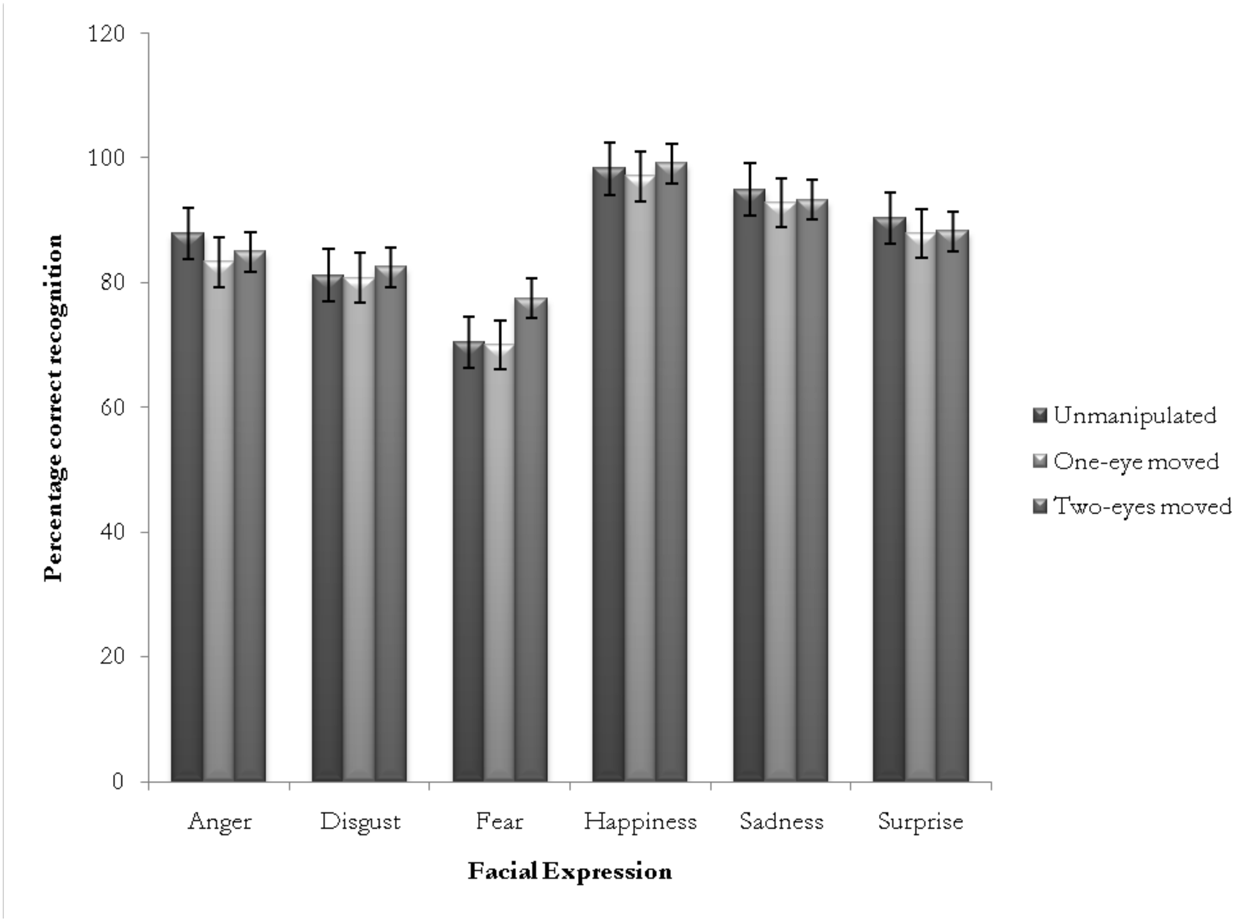

Figure 17. Correct recognition scores for each facial expression under the three manipulation conditions.

30.2.1.2Reaction Time

Reaction times were subject to a two way analysis of variance, with the form expression (anger, disgust, fear, happiness, sadness and surprise) by manipulation (unmanipulated, one eye moved, and two eyes moved).

A significant effect of expression was found ($F_{(5, 195)} = 51.399$, $p < .0005$), revealing that the expression of fear had the longest latencies, and happiness the shortest; as can be seen in Figure 18. A significant effect of manipulation ($F_{(2, 78)} = 8.160$, $p < .001$) was found, indicating that latencies were significantly different across the three conditions.

No significant interaction was found between expression and manipulation ($F_{(10, 390)}$ =0.901, p = .532).

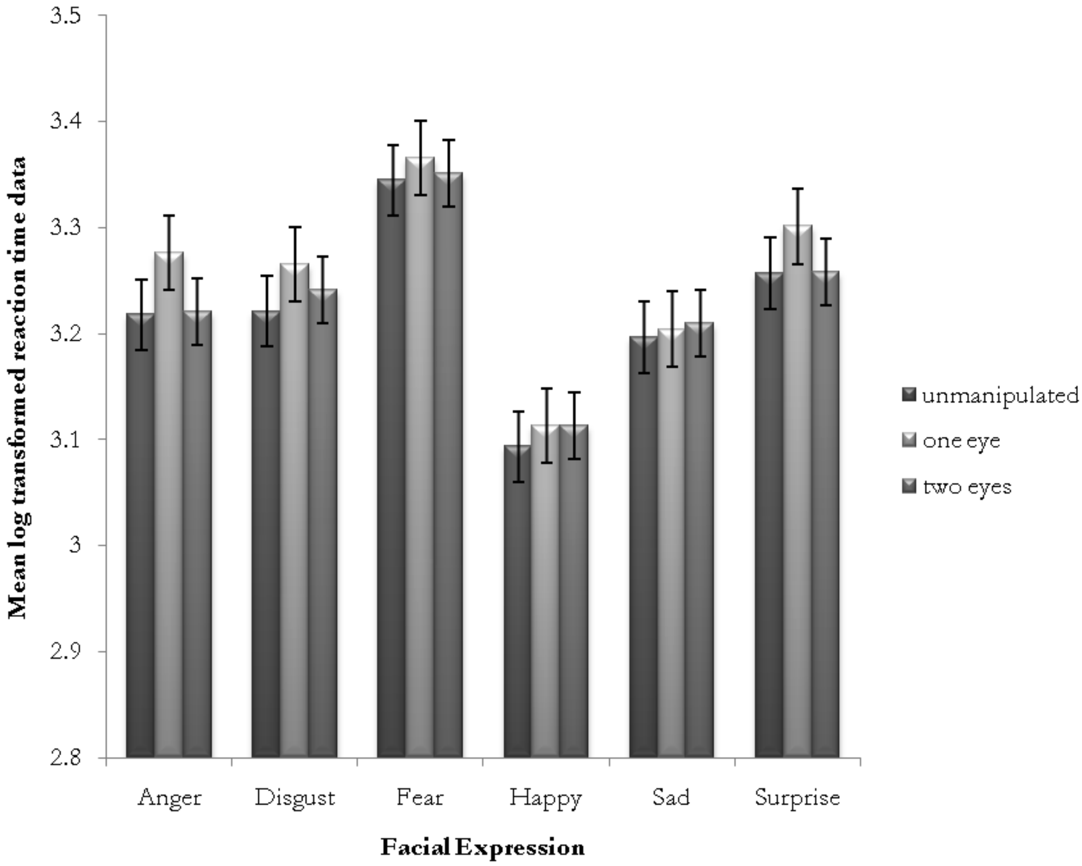

Figure 18. Correct reaction time data for each facial expression under the three manipulation conditions.

30.2.1.2.1Reaction time: Follow up analyses

As the main aim of the experiment was to investigate the impact of the eye manipulation on each expression, an individual ANOVA was conducted on the manipulation data for each expression.

The follow up analysis revealed a significant effect of manipulation for the expressions anger ($F_{(2, 78)}$ = 6.004, p < .005), and surprise ($F_{(2, 78)}$ = 4.264, p < .05), with the data indicating longer latencies for one eye moved expressions compared to unmanipulated or two eyes moved expressions. T-tests confirmed that for these two expressions a significant difference lay between unmanipulated expressions and one eye moved expressions (anger = (t = 2.928, df = 39, p < .05); surprise = (t = 2.573, df = 39, p < .05)) with one eye moved expressions taking longer to respond to than unmanipulated faces. A significant difference was also found between one eye moved expressions and two eye moved expressions (anger = (t = 3.072, df = 39, p < .005), surprise = (t =2.416, df = 39, p < .05)), with one eye moved expressions taking longer to respond to than two eyes moved expressions. However, no difference was found between unmanipulated expressions and two eye moved versions (anger (p =.822) surprise (p = .941)).

As the accuracy data for these two expressions indicated that expressions which had no manipulation applied or a second order manipulation applied (two eyes moved) were recognised with more accuracy than one eye moved versions, no evidence of a speed accuracy trade off was found. Therefore suggesting that for these two expressions first order configural processing (one eye moved manipulation) was more disruptive to recognition.

30.3 Discussion

The aim of experiment five was to investigate the impact of first order and second order manipulations on the recognition of each of the six facial expressions of emotion. Previous research (White, 2002; Calder et al. 2002b) has suggested that facial expressions are based on first order configural information and processing and it would therefore have been expected that expression recognition would be reduced more when a first order manipulation (one eye moved) had been applied to the face than when a second order manipulation (two eyes moved) had been applied. However, the results of experiment four in the current thesis had found no significant evidence of a differential effect of first and second order manipulations on expression matching; suggesting that expressions (overall) are not more reliant on first order configural processing than second order.

Experiment five confirmed the results of experiment four; the first order manipulation was not more disruptive to expression recognition than the second order one. Recognition accuracy of each of the six basic facial expressions of emotion was not significantly affected by applying either of the two configural manipulations. In fact, recognition accuracy remained at very similar levels regardless of whether the face was manipulated or not, and regardless of which type of manipulation had been applied. Thus suggesting that regardless of the expression being investigated, the eye displacement manipulation does not impact on facial expression recognition.

In experiment four a null effect of manipulation had been found and the present experiment confirmed this null effect with a recognition task. The recognition task was employed to not only investigate the ability to recognise facial expressions when the eye displacement manipulations had been used, but also to assess whether the null effect of manipulation found in experiment four was due to the matching paradigm used. The current experiment suggests that the null effect is a real phenomenon, and the first and second order manipulations do not impact on facial expression recognition. It is therefore possible that the manipulations do not disrupt configural information, or that the disruption to configural information is not strong enough to disrupt the processing of the expression per se. Featural processing is not precluded by the manipulations at all and therefore could be employed under the conditions. As the reaction times are very similar to those found in experiment two with non-composites, where the predominant mode of processing was featural, it is suggested that this mode of processing is probably being employed in the current manipulations.

Reaction time data confirmed that there was not an overall dissociative effect of first and second order configural manipulations on the recognition of expressions. However, longer response latencies were found for the expressions of anger and surprise in the first order condition when compared to either the unmanipulated expressions or second order expressions. An examination of the accuracy data for these expressions did not reveal a speed accuracy trade off (participants were not more accurate in recognising these expressions because they were taking longer to process them). Therefore suggesting that for these two expressions the first order manipulation was more disruptive to the processing strategy. Interestingly, this pattern of results was also found for the expressions of disgust and fear, although the analyses did not reach significance. In experiment three the expressions of anger, fear and disgust had been found to be more impacted by the featural manipulation, therefore the results of the present experiment support the suggestion that the difference found between expressions could be because of the different types of configural information being employed. However, based on the accuracy data and the null effect of manipulation it is not concluded that the anger and surprise expressions are more based on first order processing than second order.

31 GENERAL DISCUSSION

The overall results of experiments four and five do not support the hypothesis (White, 2002) that facial expressions, per se, are more reliant on first order processing than second order. In the present experiments no evidence was found that either expression matching or expression recognition was more disrupted by applying a first order manipulation than a second order. Whilst the reaction time data (experiment five) for the expressions of anger and surprise indicate that participants were slower to recognise these two expressions when the first order processing had been disrupted, the accuracy data does not suggest that these expressions are more reliant on this processing strategy than the second order one. Further, the reaction time data is very similar to that found in other experiments in this thesis where configural processing has been precluded, encouraging featural processing, therefore suggesting that participants in experiments four and five were using this processing strategy. It is therefore concluded that facial expression matching and recognition are not reliant on different types of configural processing; rather they are reliant upon configural processing per se.

In experiments six and seven the attention of the thesis returns to the configural/featural debate, this time investigating whether a switch in the processing mode employed when inverting faces can be ascertained. As the evidence in the thesis so far suggests that expressions are primarily configurally based (with no difference between first and second order configuration) and recognition is highly disrupted by inversion, it is hypothesised that the processing mode being employed when configural is not available is featural. In previous research on facial identity some evidence has been found that suggests there is a clear point at which processing changes from configural to featural. Therefore, experiments six and seven were designed to test this theory for facial expressions.

Chapter Six

ROTATION OF FACIAL EXPRESSIONS

32 ABSTRACT

The previous studies conducted in the thesis provide evidence that the six basic facial expressions of emotion are primarily processed configurally. Further, when the configural processing strategy is disrupted or precluded, facial expressions are still recognised with above chance accuracy, suggesting that a secondary processing strategy is available. This thesis and previous research suggests that featural processing is the secondary strategy. Therefore, in order to ascertain what happens as the configural strategy is disrupted and featural takes over, a rotation manipulation was employed in experiments six and seven. By measuring the time taken to discriminate between facial expressions of emotion and neutral facial expressions it was possible to investigate whether processing switches from configural to featural at specific angles of rotation, or whether as expressions are rotated from upright there is a gradual loss of configural processing. Experiment six supported the latter hypothesis. Experiment seven then went on to investigate whether individual facial expression features are also

impacted by rotation and found that they are not. Therefore, indicating that as expressions are rotated from upright the featural processing strategy remains available. This chapter therefore provides evidence that as facial expressions are rotated from upright, configural processing is gradually lost and featural processing becomes the primary processing strategy.

33 INTRODUCTION

The rotation manipulation has been used to ascertain whether there is a switch in the processing strategy used for facial identity processing, between configural and featural, or whether there is a general decline in the ability to process faces configurally as they are rotated from upright. There is disagreement in the literature regarding this issue, with some research suggesting a gradual decline and some suggesting a definite switch. So far, no consensus has been reached on facial identity processing.

Research by Sjoberg and Windes (1992), Sturzel and Spillman (2000) and Murray, Yong and Rhodes (2000) all supports the hypothesis that there is a discontinuity in the ability to process faces between certain angles of rotation. Sjoberg and Windes (1992) found the discontinuity to be between 60 and 120 degrees from upright, whilst Sturzel and Spillman (2000) reported it lay between 94 and 100 degrees (a much more specific 'switch' than that found by Sjoberg & Windes) and Murray, Yong and Rhodes (2000) reported a switch between 90 and 120 degrees. So far, no agreement has been reached on the angles at which the switch actually occurs.

This is possibly due to differences in how the discontinuity is measured and the stimuli and task employed to investigate the change in processing. All three of the studies discussed above used the Thatcher illusion as stimuli, with Sjoberg and Windes measuring reaction time to decide whether a face was “normal” or “abnormal”, Sturzel and Spillman recording the angles at which participants’ indicated they could detect a Thatcherised face changing from being grotesque to pleasant and Murray et al. requesting participants’ to rate the bizarreness of faces as they were rotated. Thus, none of the studies which have indicated a sharp discontinuity between the two processing strategies are comparable on the way they measured the discontinuity, or the task employed. Further, the methodology employed was also not comparable. Sturzel and Spillman (2000) placed photographs of Thatcherised and non-Thatcherised faces onto discs which were rotated manually from upright to inverted and vice versa at a speed of 30 degrees per second. However, the authors also report that this rotation speed was “slightly adjusted around this value for each observer to enable comfortable performance”, meaning that no accurate comparison could be made between observers. Sjoberg and Windes (1992) employed Thatcherised and non-Thatcherised mac-a-mug faces and randomly presented them on a projector screen at 6 angles of rotation (0°, 60°, 120°, 180°, 240° and 300°). Participant’s reaction times were recorded on a two button reaction time box in front of the participant. Therefore Sjoberg and Windes had provided a more objective form of measurement for the angle of rotation. Murray et al. (2000) extended the use of rotation by employing photographs of both configurally distorted faces (Thatcher) and featurally distorted faces (eyes whitened or teeth blackened). These authors then rotated the faces in steps of 15 degrees, therefore using even smaller 'steps' of rotation. It can therefore be seen that comparison and replication of the research is difficult.

In direct competition with the above studies and the suggestion that there is a sharp change in the processing strategy employed between certain angles of rotation, are studies which provide evidence for a gradual decline in the ability to employ configural processing for faces, with rotation from upright. However, this research also suffers similar problems to those which suggest a discontinuity between certain angles of rotation with a change in processing strategy. Lewis (2001) found that reaction time latencies to deciding whether photographs of faces were Thatcherised or not increased in a relatively flat pattern. Lewis rotated the faces through 360 degrees in 10 degree steps and participants were asked to indicate whether a face was Thatcherised or not and reaction times were recorded. This method is therefore very similar to that used by Murray et al. whilst providing an even more sensitive measure of rotation angle. Lewis found no evidence of a discontinuity in reaction times to make a Thatcherised decision; instead, participants gradually took longer to make a decision as the face was rotated from upright, indicative of a gradual decline in configural processing. Whilst the study failed to find a linear component to the reaction time increases there was also no significant evidence of the discontinuity previously found by other researchers, and Lewis concluded that the data represented a gradual loss of configural information.

A linear relationship was found by Collishaw and Hole (2002) who provided an investigation of rotation by employing faces where featural processing had already been disrupted, by the use of blurred images of famous faces. Through the use of blurred faces these authors were able to investigate what happens to configural processing of rotated faces when featural processing is not so readily available. Collishaw and Hole also rotated faces at specific angles; rotating faces from upright to inverted, through 22.5 degree steps. Participants' were asked whether the face was famous or not. They found configural processing was linearly affected by rotation, with recognition decreasing as faces were rotated from upright.

Lewis and Glenister (2003) investigated the ability to learn and retrieve information about whole faces and individual facial features when they are presented at different angles of rotation. They employed greyscale computer generated images and only three angles of rotation, 0 degrees, 90 degrees and 180 degrees. These authors were also investigating the impact of these three angles of rotation on the recognition of individual facial features. The task employed was a learning paradigm, where participants underwent a learning phase with the faces and features, and in the experimental phase were asked to correctly identify the face or feature when presented with two faces/features. It was found that for whole faces recognition gradually declined with the increasing angles of rotation, however, the same was not found for facial features. Thus, again, it can be seen that differences in methodology between the studies make comparisons and replications difficult; and the extrapolation of effects to expressions exceedingly hard.

The use of rotation to investigate facial expression processing has so far not been published, therefore, the aim of the present two studies was extend the use of this methodology to investigate the impact of rotation upon the processing of facial expressions of emotion and individual facial expression features.

Whilst research on facial identity has employed other manipulations alongside that of rotation, for example, the Thatcher illusion and blurred faces, as facial expression recognition and rotation has not been investigated it would be advantageous to discover what happens with unmanipulated expressions when they are rotated. Therefore the present research employs normal unmanipulated facial expressions, to investigate the impact of rotation on recognition and the change in processing strategy as facial expressions are rotated upright.

34 EXPERIMENT SIX

The aim of experiment six was to investigate the impact of rotation upon the processing of full facial expressions and to attempt to ascertain whether there is a perceptual switch in processing of configural and featural information or a general decline in processing ability with facial expressions. A simplified recognition task was employed for this experiment where participants were required to indicate whether they thought a face was portraying an expression or was neutral. This method provided a simplified task for participants, thus making it more akin to facial identity experiments where participants are required to indicate whether a face is bizarre or not, Thatcherised or normal, familiar or unfamiliar; rather than to make a recognition decision.

As no prior research on the impact of rotating facial expressions exists, the hypotheses are necessarily tentative. From the results of earlier experiments in this thesis it would seem that facial expressions are primarily processed configurally, although even under manipulations (configural and featural) which seriously degrade the information available from a face recognition still remains at above chance level, indicating that another processing strategy can be used for facial expression recognition. It is hypothesised that this mode is featural processing. In the current experiment it is expected that rather than a switch in processing strategy being evident from a discontinuity in the reaction times to expressions, a gradual increase in processing time will be observed. This is because both processing strategies are available in upright faces, however, with the rotation, configural processing will be gradually lost. Featural processing will continue to be used as the faces are rotated through 350 degrees, therefore, no sharp increase in reaction times is expected, as the processing strategy that will be used with rotated faces will have already been employed through all 350 degrees. The gradual increase in reaction time is expected as featural processing is not as fast as configural; therefore, as the latter mode is lost, the former will take longer to process the expressions.

34.1 Method

34.1.1 Participants

Forty-two participants took part in the study, 35 females and 7 males. All participants were in the age range of 18 to 48 years old and were undergraduate students at the University of Wolverhampton. Participation in the study was rewarded with course credits. Participants all had normal or corrected to normal vision.

34.1.2 Stimuli & Apparatus

Pictures of 2 actors from the Ekman and Freisen (1976) set, portraying all 6 of the basic facial expressions of emotion (anger, disgust, fear, happiness, sadness and surprise) as well as neutral facial expressions were taken from FEEST (York et al, 2002). The pictures were of one female (C) and one male (JJ). Using Adobe Photoshop 5.0LE the pictures were rotated through 350° in 10° steps. Each face also had the outer features removed (i.e. hair, clothing) so that no clues to orientation could be gained which might encourage mental rotation. Each face was then mapped onto a blank screen. See Figure 19 for example stimuli.

Under each face were two coloured squares on which the words 'neutral' and 'expression' were displayed. These coloured squares served as a visual reminder of the response keys, which were located on the z & m keys of the keyboards and were colour coded to match the squares on the screen. The response keys were counterbalanced across participants.

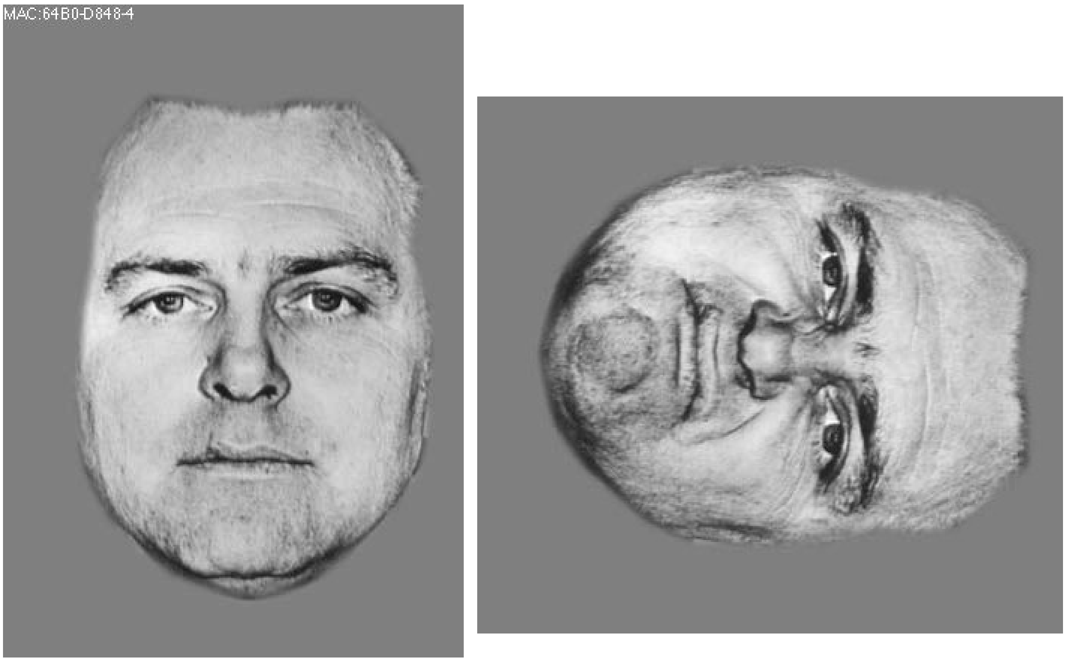

Figure 19. Pictures of JJ portraying the neutral expression at 0 degrees (left picture) and the disgust expression at 90 degrees (right picture) from upright.

34.1.3 Procedure

Presentation of the 432 stimuli was broken down into 3 versions of the experiment. As only 2 actors were employed, only 72 neutral stimuli were available for use (2 neutral pictures, rotated 36 times) compared to 432 expression stimuli (6 expressions, each rotated 36 times = 216, for 2 actors = 432). Therefore to equate the number of neutral expression stimuli and male and female pictures, 3 versions of the experiment were created into which the stimuli were divided. In each version participants saw 72 expression stimuli and 72 neutral stimuli. Half of the neutral and expression stimuli were male and half female. Therefore at each angle of rotation participants saw 2 facial expressions (1 male and 1 female) and 2 neutral expressions (1 male and 1 female). Participants were randomly allocated to one of the three conditions. Response keys were counterbalanced across participants.

Participants were tested in individual sessions and were issued standardised instructions. The instructions informed participants that their task was to decide whether a face was portraying a facial expression of emotion or whether it was neutral.

Each trial consisted of the presentation of a single face. Below each face were two coloured squares, which represented the response keys. These squares were the same colour and in the same position as the response keys, and presented on them were the response choices 'neutral' or 'expression'. The position of the response keys and therefore these coloured squares were counterbalanced across participants.

The experiment began with an instructions screen, followed by a practice session (21 practice trials, 3 from each of the 7 expressions, chosen randomly). The practice trials were followed by a further instruction screen before the experimental trials were presented. An inter-stimulus break of one second followed each trial. Each trial was presented for 3 seconds or until a response was made. Participants were instructed to respond as quickly and accurately as possible. Trials were presented in a randomised order individually generated for each participant.

34.2 Results

Both accuracy data and reaction time data were recorded from the experiment. The correct recognition scores were split according to the degree of rotation from upright (0 degrees to 180 degrees) and whether the face was portraying a neutral expression or one of the six emotional expressions. The percentage of correct recognition can be seen in Figure 20. As can be seen from the graph, there was very little impact of rotation on the correct identification of expressions as portraying an emotion or not.

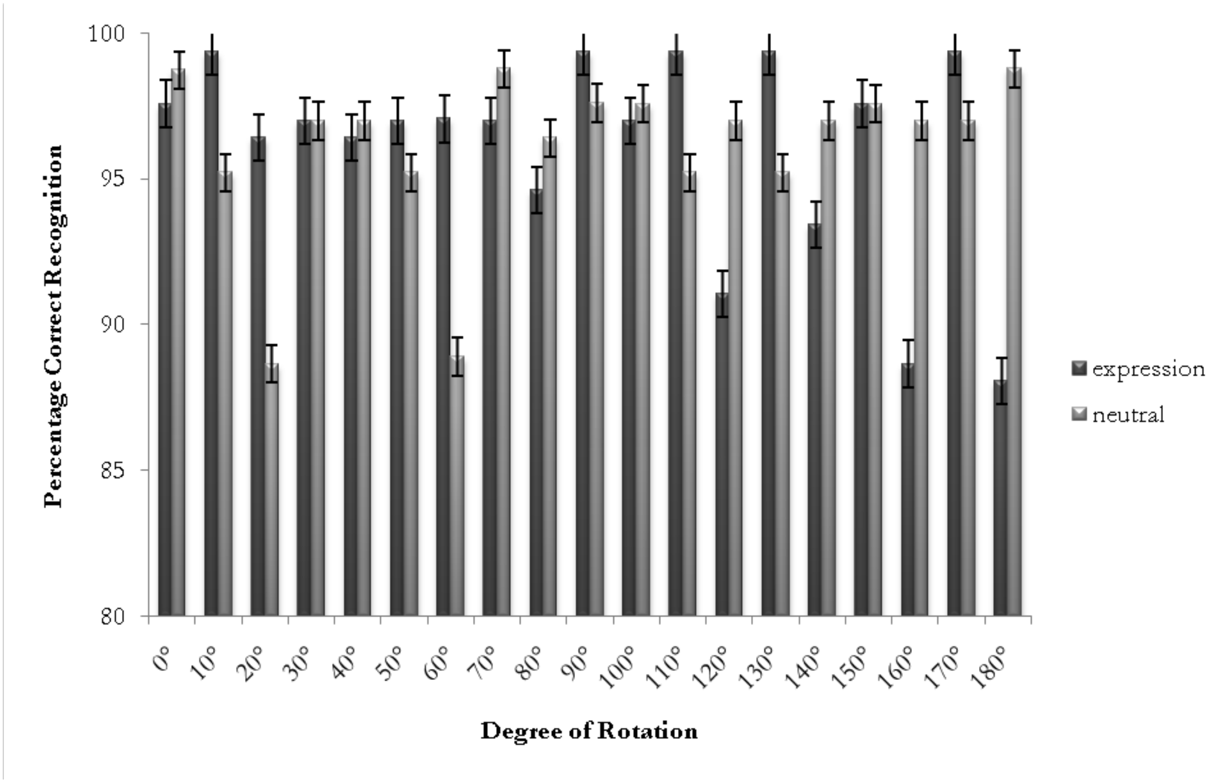

Figure 20: Percentage correct recognition of expressions as portraying an emotional expressions or a neutral expression, split by degree of rotation from upright.

The reaction times for correct trials (where participant's had correctly identified whether the face was portraying an expression or was neutral) were also split according to the degree of rotation from upright (0 degrees to 180 degrees) and whether the face was portraying a neutral expression or one of the six emotional expressions. These reaction times can be seen in Figure 20. The plot does appear to show a linear decline in ability as faces are rotated from upright, more so with emotional expressions (with the plot also appearing steeper) compared to neutral expressions. The data was then log transformed and analysed.

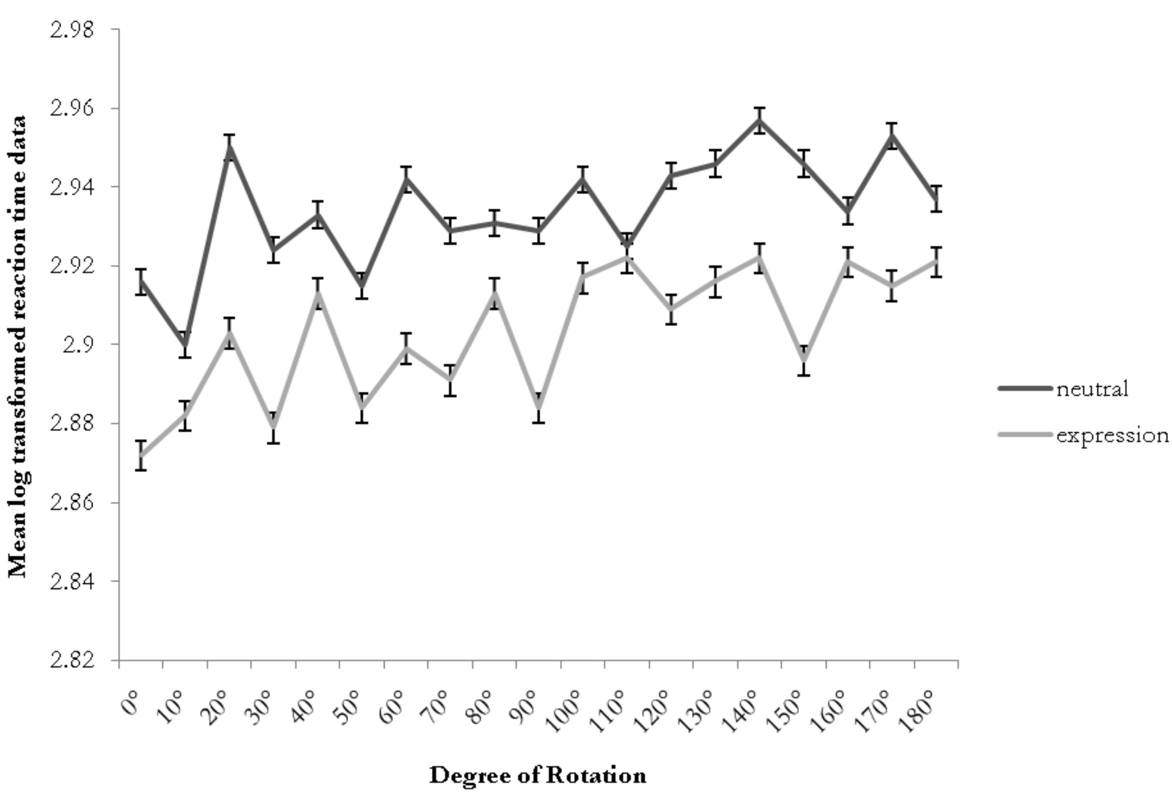

Figure 21. Reaction time taken to indicate whether a face is portraying a neutral expression or a facial expression of emotion.

34.2.1Analyses

The reaction time data was submitted to a three way analysis of variance investigating version (3 different versions of the experiment), expression (neutral or emotional expression) and degree of rotation (0 to 180 degrees from upright). This revealed no significant effect of version ($F_{2, 39}$= 1.406, p = 0.257); a significant effect of expression ($F_{1, 39}$ =15.729, $p < 0.0005$); a significant effect of rotation ($F_{18, 702}$ =1.981, $p < 0.01$) and no significant interaction between expression and rotation ($F_{18, 702}$= 0.476, p = 0.968).

34.2.1.1Follow up analyses

In order to ascertain if there was a linear component to both neutral and expression reaction times, individual one way ANOVAs were conducted on the rotation data for each type of expression. For neutral faces there was no significant effect of rotation ($F_{18, 738}$=0.935, p = 0.536). For expression faces there was a significant effect of rotation ($F_{18, 738}$=1.625, $p < 0.05$), with the polynomial contrast revealing a significant linear component ($F_{1, 39}$= 8.791, $p < 0.005$).

34.3 Discussion

The aim of the present experiment was to apply the rotation manipulation to facial expressions of emotion to investigate whether a switch in processing can be observed at particular angles of rotation, or whether there is a gradual loss of configural processing as the face moves from being upright. For the neutral facial expressions there was no observable effect of rotation, response latencies were not significantly affected by rotating these expressions from upright to inverted. For the emotional expression faces there was a significant effect of rotation and this was linear. Therefore, for the emotional expression faces reaction times linearly increased with rotation from upright. As experiment six is the first known study to have employed rotation of facial expressions of emotion it is difficult to place into the context of current knowledge.

However, the results do support the latter hypothesis presented above, reaction times gradually increased as the face was rotated from upright, and for the emotional expressions this increase was linear. Therefore supporting previous research conducted with facial identity which has suggested a gradual decline in the ability to process identity configurally (Collishaw & Hole, 2002; Lewis, 2001; Lewis & Glenister, 2003). The results of experiment six are also, therefore, in disagreement with facial identity studies which have found a discontinuity in reaction times and decision rates as faces are rotated from upright (Murray, Yong & Rhodes, 2000; Sjoberg & Windes, 1992; Sturzel & Spillman, 2000).

Of course, the hypothesis that configural processing is disrupted as faces are rotated from upright to inverted and featural processing gradually takes over as the dominant mode, would also require that featural processing is not impacted by inversion. Previous studies have indicated that features are non-orientation specific, which allows featural processing of faces to take place at all angles of rotation. Experiment seven was therefore designed to investigate this effect for facial expressions and to ascertain if the findings of experiment six can be explained by featural processing gradually taking over from configural processing.

35 EXPERIMENT SEVEN

The second rotational experiment was designed to test the hypothesis that the processing of features is non-orientation specific. Whilst a number of studies have investigated this issue, there are very often methodological problems and configural and featural information and processing are confounded. Freire, Lee and Symons (2000) suggest that such problems include the use of different stimuli actors, unnatural stimuli (e.g. photo-fit or mac-a-mug faces), and stimuli which inadvertently remove information. Further to these problems is the confound most often found, that of confusing featural and configural information and processing.

The ‘feature swap’ technique has been employed by a number of researchers to test the impact of inversion upon featural information (Tversky & Krantz, 1969; Rhodes et al. 1993; Sergent, 1984). This technique involves changing the features of one face with those of another. Participants are then typically required to make decisions about which of two faces they have seen before, having been through a learning phase for recognising face parts. Faces are also shown inverted and the pattern of results indicates that inversion does not disrupt the processing of featural information (Rhodes et al. 1993). However, the main problem with this method is that by changing the features of a face the configural information is also altered, so that the results cannot therefore be ascribed to one kind of information or processing with complete certainty. Rhodes et al. (1993) found that with a feature swap experiment participants were automatically coding the second order information in the resulting face, thus interfering with the exploration of featural information. When the features that had been swapped were removed from the face context and presented in isolation the large decrements in performance disappeared. These authors therefore advise against employing such methods.

Recognition of individual features when inverted has also been investigated and provides a more direct test of inversion on featural processing. Tanaka and Farah (1993) taught participants to learn the identity of both intact and scrambled faces (for example, to learn one actors face as “Larry’s face”) then at test participants completed a forced choice task identifying which of two whole faces or which of two isolated features they had seen before. For example, they were presented with 2 noses and asked “Which is Larry’s nose”. Tanaka and Farah found that participants were more accurate at identifying features which were presented in a whole face context. However, when they presented their stimuli inverted, this advantage disappeared. Participants were more accurate at identifying inverted isolated features than they were features which were in a face context. Tanaka and Farah (1993) proposed that features are non-orientation specific as they are processed featurally, whereas faces are processed configurally, with this mode of processing being disrupted by inversion. Whilst this study avoided the confound of feature swap when using isolated features, there were still problems with the stimuli as they used mac-a-mug faces, which are known to be problematic for face research.

Therefore, Lewis and Glenister (2003) extended this research by using computer generated greyscale faces. Whilst the stimuli could be argued to be more realistic in this study, they are still not naturalistic photographs. Lewis and Glenister found that inversion of isolated features did impact on their recognition; and concluded that featural information is indeed orientation specific and that inverting isolated features disrupts the ability to recognise the feature. In comparing their research to that of Rhodes et al. (1993) Lewis and Glenister concluded that the other researchers had failed to find the feature inversion effect due to the poor quality of their stimuli; suggesting that higher quality faces, such as their computer generated ones, produce clearer results. They went on to suggest that by using more detailed features (computer generated) configural encoding of the features could take place. Lewis and Glenister therefore advocate the use of highly detailed, clear stimuli.

Whilst researchers investigating facial expressions also claim that features are non-orientation specific (Bartlett & Searcy, 1993; Searcy & Bartlett, 1996) the impact of inversion on individual expression features has not actually been investigated. Therefore experiment seven was designed to assess this claim and to add to the contribution made by experiment six by testing the hypothesis that featural processing of expressions is non-orientation specific.

The experiment employed isolated emotional facial features (eyes and mouth) presented without a facial context, to avoid the confounding of featural and configural information. Further, the features were taken from the Ekman and Friesen (1976) stimuli set of emotional expressions, therefore adhering to the suggestion of Lewis and Glenister to use high quality, detailed stimuli, and also avoiding the confound of not using naturalistic stimuli. The aim of experiment seven was to ascertain whether the processing of facial features is indeed non-orientation specific, and therefore the level of detail regarding angle of rotation was not as imperative as with experiment six. In experiment seven just 3 angles of rotation were employed (following Lewis & Glenister, 2003) upright (0 degrees), orthogonal (90 degrees) and inverted (180 degrees). The task remained the same as that used in experiment six to aid in the comparison of results.

As research in this area is somewhat contradictory, again, hypotheses are tentative. However, based on the findings of experiment six which suggested a gradual decline in the use of configural information as faces are rotated; it is hypothesised that another processing strategy is available to process facial expressions when inverted. This mode, based on research in this thesis and previously produced, is suggested to be featural. Therefore, if featural processing is employed with inverted faces it would be expected that rotation of individual features will have very little impact on their recognition. Therefore, no significant increase in reaction times to facial expression features is expected (in line with research by Tanaka and Farah, 1993).

35.1 Method

35.1.1 Participants

Thirty-three participants took part in the study, 25 females' and 8 males. All participants were in the age range of 18 to 58 years old and were undergraduate students at the University of Wolverhampton. Participation in the study was rewarded with course credits. Participants all had normal or corrected to normal vision.

35.1.2 Stimuli and Apparatus

Facial expressions portrayed by one male (JJ) and one female (C) actress were employed for this study. The actors were from the original Ekman and Friesen (1976) pictures of facial affect series and were taken from the FEEST program (York et al, 2002). These actors portrayed all 6 of the basic facial expressions of emotion (anger, disgust, fear, happiness, sadness and surprise) as well as neutral expressions.

Adobe Photoshop 5.0LE was employed to manipulated the pictures and create the experimental stimuli. Primarily each face had any external features removed that might interfere with the experiment e.g. hair and clothing. Each face then had the eye and mouth areas isolated and removed from the face context to give individual isolated facial features. The area that was removed from the face to create the features was kept as close to the actual facial feature as possible i.e. as little as possible of the surrounding face was included. Once the features had been isolated the eye areas were further changed, by removing a small triangular section at the bridge of the nose. This was to ensure that no clues to expression could be gained from this feature. Examples of stimuli can be seen in Figure 21.

Each feature was then rotated twice to produce the three experimental orientations. Each feature was presented upright, inverted (180 degrees from upright) and orthogonal (90 degrees from upright). These resulting stimuli were then presented in the experimental template so that under each facial feature were two coloured squares on which was displayed the words ‘neutral’ and ‘expression’. These coloured squares served as a visual reminder of the response keys, which were located on the z and m keys of the keyboards and were colour coded to match the squares on the screen. The response keys were counterbalanced across participants.

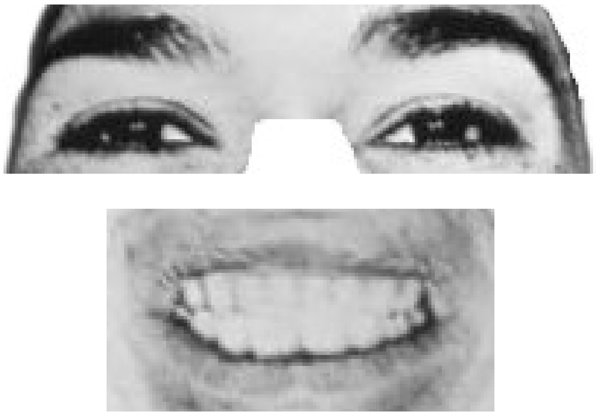

Figure 22. Female C’s happy eyes at 0 degrees from upright and fear mouth inverted

35.1.3Procedure

As only 2 actors were employed, only 2 neutral stimuli were available for use (one male and one female) compared to 12 expression stimuli (6 expressions for each actor). Therefore the number of experimental expression and neutral stimuli had to be equalised. In total there were 72 expression stimuli (6 expressions x 2 actors = 12; x 3 rotations = 36; x 2 features = 72), but only 12 neutral stimuli (1 expression x 2 actors = 2; x 2 features = 4; x 3 orientations = 12). Therefore each rotated version of the neutral feature was employed 6 times to ensure that there were as many neutral stimuli as there were expression stimuli (e.g. female neutral mouth was presented 6 times upright, 6 times inverted and 6 times orthogonal). Therefore each experiment consisted of 144 stimuli, 72 were expression stimuli and 72 were neutral stimuli.

Participants were tested in individual sessions and were issued standardised instructions. The instructions informed participants that their task was to decide whether a facial feature was portraying a facial expression of emotion or whether it was neutral.

Each trial consisted of the presentation of a single feature (eyes or mouth). Below each feature were two coloured squares, which represented the response keys. These squares were the same colour and in the same position as the response keys, and presented on them were the response choices ‘neutral’ or ‘expression’. The position of the response keys and therefore these coloured squares were counterbalanced across participants.

The experiment began with an instructions screen, followed by a practice session (14 practice trials which consisted of 2 randomly chosen versions of each expression). A further instruction screen followed the practice trials before the experimental trials were presented. Each trial was presented until a response was made and was followed by a one second interstimulus break. Participants were instructed to respond as quickly and accurately as possible. Both reaction time data and accuracy were recorded. All trials were presented randomly for each participant.

35.2 Results

Both accuracy and reaction time data were collected from the study. The percentage correct recognition scores can be seen in Table 9. The accuracy data reveals that for the expression features, eyes were recognised with more accuracy than mouths; whilst for neutral the mouth feature was recognised with more accuracy than neutral eyes. Further, neutral mouths were recognised better than expression mouths, but this trend was reversed for the eye features.

Table 9: Percentage correct recognition of expression and neutral features in each of the three rotations.

	Neutral eyes	Expression eyes	Neutral mouth	Expression mouth
0 degrees	78.5%	93.66%	93.91%	80.25%
	(sd. 2.358)	(sd. 0.708)	(sd. 1.606)	(sd. 1.558)
90 degrees	80.25%	86.33%	94.16%	77%
	(sd. 2.485)	(sd.1.138)	(sd. 1.185)	(sd. 1.437)
180 degrees	68.66%	83%	85.58%	83.58%
	(sd. 3.042)	(sd. 1.741)	(sd. 1.754)	(sd. 1.286)

The reaction times for correct trials (where participant's had correctly identified whether the features were portraying an expression or were neutral) were split according to the degree of rotation (0 degrees, 90 degrees and 180 degrees), the feature shown, and whether the feature was portraying a neutral expression or one of the six emotional expressions. These reaction times can be seen in Figure 22. The data were then log transformed and analysed.

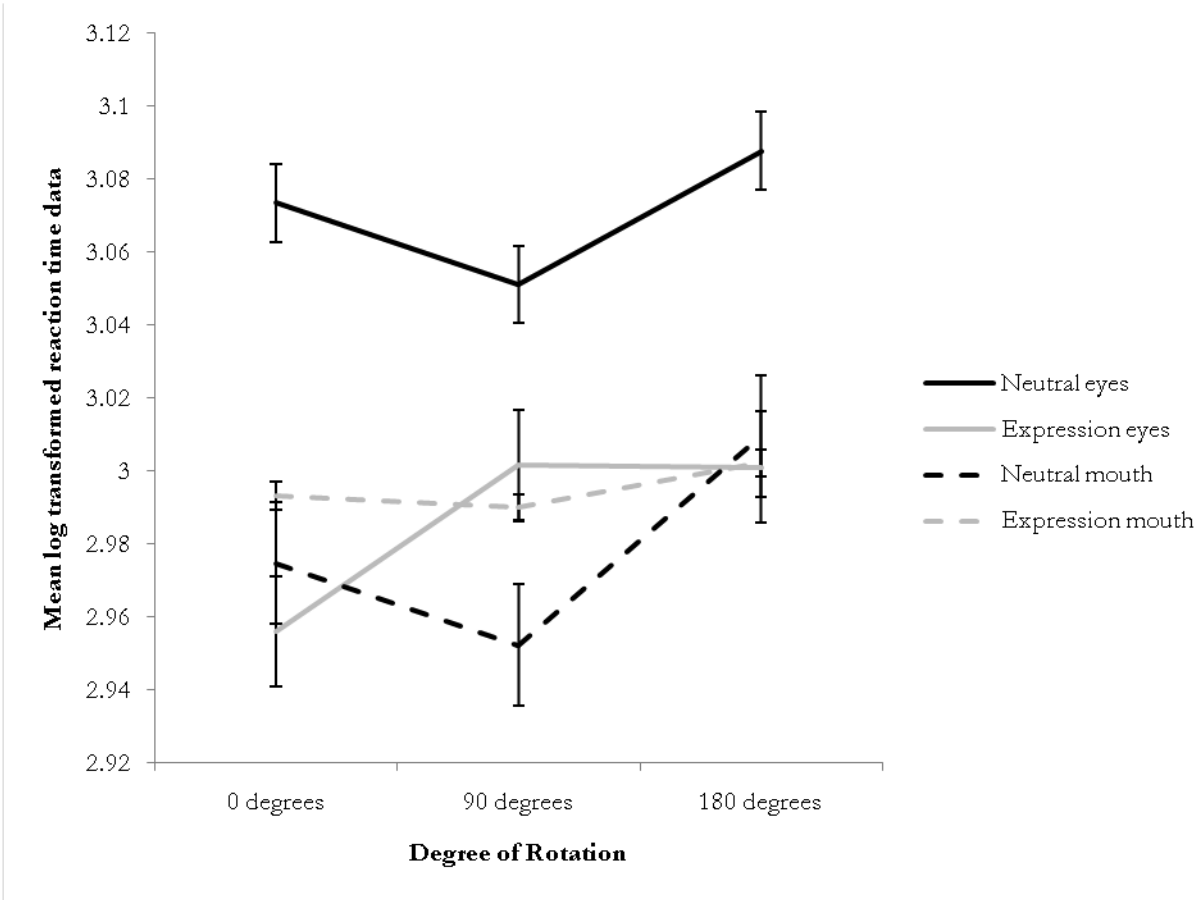

Figure 23. Reaction time latencies to neutral expression features at the three angles of rotation

35.2.1Analyses

The reaction time data was submitted to a three way analysis of variance investigating feature (eyes or mouth), expression (neutral or emotional expression) and degree of rotation (0 to 180 degrees from upright). This revealed a significant effect of feature ($F_{1, 32} = 19.495$, $p < 0.0005$), with the eye feature eliciting longer latencies than mouth feature; a significant effect of expression ($F_{1, 32} = 10.244$, $p < 0.005$) which revealed significantly longer reaction time latencies for neutral expressions than emotional expressions; and a significant effect of rotation ($F_{2, 64} = 6.572$, $p < 0.005$) showing that features seen completely inverted (180 degrees) took longer to recognise than those seen at 0 degrees and 90 degrees. There was also a significant interaction between expression and feature ($F_{1, 32}$ =22.566, $p <$ 0.0005); this interaction occurred because with neutral expressions reaction times to identify isolated eye features were longer than to identify mouth features, whereas for expressions, this trend was reversed. Finally, a significant interaction between expression and rotation was found ($F_{2, 64}$ =3.980, $p < 0.05$), which occurred because expression times gradually increased across the three rotations, whereas neutral expressions had faster reaction times to 90 degree stimuli.

35.2.1.1Follow up analyses

To ascertain whether there was a linear increase in reaction times for both neutral and emotional expression stimuli, follow up analysis of variance were conducted on the data for neutral and emotional expressions reaction time data separately. Two way ANOVAs were conducted on the rotation data to investigate feature (eyes and mouth) and rotation (0 degrees, 90 degrees and 180 degrees).

For neutral expression features there was a significant effect of feature ($F_{1, 32}$= 32.446, $p < 0.0005$) which revealed that participants took significantly longer to respond to the eye features compared to mouth's with neutral expressions; and a significant effect of rotation ($F_{2, 64}$= 6.948, $p < 0.005$) with the data revealing that the longest latencies were to 180 degree rotations, then 0 degree rotations and participants responded the fastest to 90 degree rotations. The polynomial contrast therefore revealed that the linear component was not significant for neutral expressions ($F_{1, 32}$= 3.769, p = 0.061). No significant interaction was observed (p = 0.285).

For emotional expression features there was no significant effect of feature ($F_{1, 32}$= 1.076, p = 0.307) and no significant effect of rotation ($F_{2, 64}$= 1.912, p = 0.156). No significant interaction was observed (p = 0.456).

35.3 Discussion

The results of experiment seven support the hypothesis that for individual features from facial expressions of emotion there was no significant effect of rotation, supporting the hypothesis that individual facial expression features are non-orientation specific. There was a small linear increase in reaction time as the features were rotated through the three angles, however, the effect failed to reach significance. Interestingly, this result was not found for neutral expressions, where an increase in reaction times was observed across the different angles of rotation.

The present experiment has therefore provided an empirical test of the effect of rotation and inversion on the ability to discriminate facial expression features and provides support for previous claims that facial expression features are non-orientation specific (Bartlett & Searcy, 1993; Searcy & Bartlett, 1996). The criticisms levied at feature rotation studies have also been controlled for. Lewis and Glenister (2003) claimed that previous studies had not found an inversion effect of features as the stimuli used were not high quality and detailed, therefore the present study employed photographs as stimuli – which are arguably more high quality and detailed than the computer generated features employed by Lewis and Glenister. This also addresses various other criticisms, such as the use of different stimuli actors, unnatural stimuli (e.g. photo-fit or mac-a-mug faces), stimuli which inadvertently remove information and the confusing of featural and configural information (Freire, Lee & Symons, 2000). The fact that no impact of rotation was still found for the processing of features provides robust evidence that processing of features is non-orientation specific.

The lack of an effect of rotation on facial expressions of emotion features is also evidence that featural processing is not impacted by inversion, or at least, not to the same degree as configural processing. Therefore, providing evidence that in experiment six the gradual increase in reaction times to facial expressions was evidence of a general decline in the ability to process the expressions configurally and featural processing became the dominant, but slower, processing strategy.

36 GENERAL DISCUSSION

Experiments six and seven have investigated the impact of rotation on the ability to discriminate facial expressions of emotion and have provided evidence to suggest that as facial expressions are rotated from upright to inverted there is a gradual loss of configural processing. The slower reaction times observed at increasing angles of rotation are due to the use of featural processing which is a slower processing strategy than configural. Experiment seven provided a further investigation into the gradual increase in reaction times observed in full facial expressions in experiment six and supported the hypothesis that facial expression features are non-orientation specific. This lack of specificity for features would mean that as the expressions are rotated from upright and configural processing is increasingly disrupted; featural processing would still be available, although reaction times would increase as the processing strategy takes much longer than configural (as already seen in previous experiments in this thesis).

The disagreement in previous research regarding the effect of rotation on the configural processing strategy had provided two clear hypothesis for facial expressions, either that configural processing was gradually lost (as was found in experiments six and seven) or that there was a switch in processing strategy at a certain angle of rotation. As an investigation into the ability to detect and discriminate facial expressions of emotion as they are rotated through 180 degrees had never been investigated the hypotheses postulated by the presented thesis were extremely tentative. However, the results of the experiment provide clear evidence that as facial expressions are rotated from upright there is a gradual increase in reaction times, indicative of a gradual loss in the faster processing strategy of configural and an increasing reliance on featural processing. The fact that processing of features is non-orientation specific also supports this conclusion.

Chapter Seven

GENERAL DISCUSSION

37 ABSTRACT

This chapter reviews the experimental work conducted in this thesis and considers the findings in relation to the aims of the thesis described in chapter one. The findings from the thesis are discussed in relation to previous research conducted in this field and the implications of the current research are discussed. Finally a consideration of further research to be conducted and the potential application of the findings are also presented.

38 INTRODUCTION

The primary aim of this thesis was to assess the impact of various configural and featural manipulations upon the ability to recognise the six basic facial expressions of emotion. Whilst research in this area has seen an increase in popularity over the last few decades, investigations have been somewhat sporadic and varied in their approach and use of facial expressions. General conclusions about facial expression perception are often formed on the basis of experiments which have employed 'cherry picked' expressions. Whilst this approach to the use of expressions has been identified and acknowledged as potentially problematic by researchers who employ only certain emotions, it has continued to be a theme throughout this area of investigation. This has then had an effect on the manipulations which have been employed with facial expression research. The manipulations used are generally borrowed from facial identity research (an extremely well developed and validated area) and employed with these various combinations of facial expressions. This has resulted in numerous studies investigating the impact of manipulations upon facial expressions, but no clear and concise investigation of these manipulations upon the *same* facial expressions. At best, conclusions can be drawn on the facial expressions used, but at worst (and most likely to happen) is conclusions are proposed for facial expressions per se; with no consideration of the potential impact of having omitted some facial expressions or of the impact of the manipulations upon the individual expressions used.

The present research therefore aimed to replicate and extend some of the key research findings on the processing and recognition of facial expressions of emotion, whilst including all six of the basic facial expressions of emotion (Ekman and Friesen, 1976) and considering the effect of manipulations upon the individual expressions of emotion. The finding from the current thesis suggests that whilst there seems to be an overarching configural processing strategy specialised for facial expression perception, there is also another processing strategy, featural, which is specialised for inverted expressions and also, it would seem, for the expressions of disgust and fear. The research therefore provides an empirical investigation of the processing strategies for individual facial expressions of emotion and suggests that research on facial expressions should always, at the very least, include all six of the basic facial expressions of emotion, and at best, consider the effects of manipulation employed on individual expressions.

39 REVIEW OF MAIN FINDINGS

Whilst the overriding conclusion of the present thesis is that configural processing is the primary strategy being employed with facial expressions of emotion, the results for individual expressions in some of the experiments suggest the possibility that some expressions are processed as effectively by the featural mode. A review of the experimental work and the conclusions is now provided.

In experiment one a reliable inversion effect was found for all six of the basic facial expressions. Research on the famous facial inversion effect has proposed, and supported, the theory that the effect represents a disruption to configural processing (Bartlett & Searcy, 1993; Lewis & Johnston, 1997; Rhodes, Brake & Atkinson, 1993; Sergent, 1984). When a face is viewed in the inverted orientation featural processing becomes the dominant strategy, due to the disrupted, or removed, configural processing. As the inversion effect does represent such a robust test of configural processing, the results of the first part of experiment one provide support that all six of the expressions are primarily processed configurally. This result concurs with a large amount of research which has proposed that facial expressions are primarily processed configurally (Bartlett & Searcy, 1993; Calder et al. 2000b; Parks, Coss & Coss, 1985; White 2002). Further, the fact that even when inverted, all six of the expressions could still be recognised with above chance accuracy suggests that there is another processing strategy which can be used for facial expression recognition, and it is hypothesised that this mode is featural.

To test this hypothesis further, the Thatcher illusion (Thompson, 1980) was employed. The Thatcher illusion provides a further configural manipulation: in the illusion the eyes and mouth are inverted in an otherwise normal face, thus creating a configural change. When the resulting Thatcher faces are inverted, research has shown that participants fail to recognise that the face has been altered, and often match it with unmanipulated, smiling faces (Bartlett & Searcy, 1993; Leder, Candrian, Huber & Bruce, 2001; Searcy & Bartlett, 1996). It has been proposed that this is due to inverted faces being processed featurally: as the manipulation does not interfere with featural processing this mode is employed to process the face and participants fail to see that a disruption to the configural information has been applied. Further, as the manipulation is configural and configural processing is precluded, again the effect is not seen. In experiment one participants were asked to recognise the emotion being portrayed by both upright and inverted faces which had the Thatcher illusion applied to them. As expected, applying the manipulation to an upright emotion expression severely reduced participants' ability to recognise the emotion being shown; however, when comparing performance with normal inverted faces and Thatcher inverted faces an interesting effect was found. It was hypothesised that due to the upright features in an inverted Thatcher face there may be a facilitative effect for the recognition of some facial expressions. Previous research (McKelvie, 1995; Prkachin, 2003) had suggested that happiness and surprise were based on identifiable features, and as such were processed more featurally compared to other expressions. These authors had also suggested that the expressions of anger, disgust, fear and sadness are primarily configural expressions, due to the consistent inversion effect found with them. If, as McKelvie and Prkachin had suggested, surprise and happiness were featurally based, then it might be expected that when participants see an inverted face with upright features (inverted Thatcher face) they would recognise these expressions with more accuracy than if they saw a normal inverted face. However, evidence was found which contradicted this argument, and instead found featural facilitation for the expressions of disgust, fear and sadness. Thus suggesting that these three expressions may be more featural than configural. At this time of course, this hypothesis was speculative.

Experiment two provided a further test of the role of configural processing in facial expressions by employing the composite effect (Young, Hellawell & Hay, 1987). Rhodes et al. (1993) have suggested that the effect provides an extremely direct way of testing the impact of configural information on the recognition of faces. The composite effect provides such a robust test of configural processing as the top and bottom of two different faces are aligned to form the perception/image of a new face. Whilst no featural information is changed in either half, the new face image encourages configural processing, by the mere suggestion that the two halves form a whole face. Participants are then asked to identify the face (or expression) in either half of the face. What both Young et al. (1987) and Calder et al. (2002b, with expressions) found is that participants can readily identify the person or expression in either half of a composite; however, the reaction times are greatly increased compared to those for non-composites (where the two halves are misaligned). This is because participants begin to process the face configurally – induced by the perception of a whole face, which would normally be processed in this way - then realise that the processing strategy is unsuccessful and switch to processing the image featurally. Featural processing is a serial form of processing and thus takes longer than configural, thereby increasing reaction times to identify the person or expression. Previously Calder et al. (2000b) had used the composite effect with facial expressions but had only combined certain expressions, and unfortunately these were not the suggested featural expressions of happiness and surprise (McKelvie, 1995; Prkachin, 2003).

Therefore experiment two was designed to assess the impact of another configural manipulation on the recognition of expressions. This experiment combined the two previously suggested featural expressions (happiness and surprise) and two of the previously suggested configural expressions (anger and sadness); whilst also acknowledging that in experiment one evidence had been found for sadness being more featural. It was hypothesised that if happiness and surprise are primarily processed featurally, then the composite effect would not be evident or would be reduced with these expressions, as their primary processing strategy would override the configural one. No evidence was found for this, as a reliable composite effect was found across all combinations of expressions, even those including sadness. The conclusion from experiment two was that even when expressions are employed for which there is evidence of their reliance on featural processing, the dominant processing mode is configural; in agreement with experiment one.

So far the two experiments conducted have investigated the impact of configural manipulations upon the processing of facial expressions and inferred conclusions regarding featural processing. So in experiment three a featural manipulation was employed to assess the impact of removing this mode of processing upon the recognition of facial expressions of emotion. Research has shown that by removing the high spatial frequencies in a face the edge based, featural information is disrupted, whereas removal of low spatial frequencies removes coarse, configural information (Costen, Parker & Craw, 1994; Morrison & Schyns, 2001; Sergent, 1984). One way to remove the high spatial frequency information is to blur the image, and this manipulation was employed in experiment three. Experiment three replicated an identity study (Collishaw & Hole, 2002) and investigated both the featural manipulation of blurring and the configural manipulation of inversion, and also a combination of these two forms of manipulation. In this study an inversion effect (i.e. reduced recognition when inverted) was found for five of the expressions, but not for happiness. The lack of inversion effect for this expression is explained in the context of the happy face advantage reported by other researchers (Kirita & Endo, 1995) in light of the lack of evidence found in the current thesis for the expression being more featural, as has previously been suggested (McKelvie, 1995; Prkachin, 2003). The results of applying the blur manipulation to the six expressions were a reduction in the recognition of anger, disgust and fear, but no impact for happiness, sadness and surprise. The results therefore concur with those found with the Thatcher illusion in experiment one, where evidence of featural facilitation for disgust and fear was found; further suggesting that the featural mode of processing is important for these expressions. However, no such concurring evidence was found for sadness, which was also found to have featural facilitation in experiment one: with blur this expression was not affected and recognition remained high. As expected, when the configural and featural manipulations were combined (blurring and inverting the expressions) recognition of all six expressions was severely reduced. The results of experiment three therefore provide further support that configural processing is primary for all six expressions, whilst also showing that for the expressions of anger, disgust and fear, a featural manipulation also has a large effect on their recognition. In line with the results from experiment one in the current thesis, these findings indicate that although disgust and fear are primarily processed configurally, featural processing is also as important for these expressions, as evidenced by the large decrement in recognition when this mode of processing is not available. Again, as in the previous two experiments, recognition of all six facial expressions remained at above chance with all three of the manipulations applied, showing the overwhelming ability to recognise facial expressions even when both modes of processing have been largely disrupted.

The results of the first three experiments provide supporting evidence for the theory that facial expressions can be recognised via two modes of processing, configural and featural, but that configural processing is the dominant method used. The expressions of happiness, sadness and surprise have so far only been affected by configural manipulations, suggesting that although the featural mode can be employed with these expressions, it is not as important as configuration. The findings also show that the expressions of disgust and fear have been affected by featural manipulations, as well as configural, therefore suggesting that for these expressions both modes of processing are equally important. The first three experiments therefore established the importance of configural processing to all six of the basic facial expressions of emotion.

Previous research had suggested that rather than a configural/featural divide between how facial expressions are processed, the difference may lie in the type of configural information/processing. Calder et al. (2000b) and White (2002) had provided evidence that facial expressions are more reliant upon first order configural information, compared to facial identity which is reliant upon second order processing. It was therefore postulated that what might underlie the differences found for the expressions of disgust and fear was reliance upon a different type of configural processing compared to the other expressions.

Experiment four replicated and extended the White (2002) study which investigated first and second order configural influences on facial expression matching. The present research extended the original study by including all six of the basic expressions (White had only employed anger, fear, happiness and sadness) and by conducting follow up analyses to discover whether the difference found between first and second order processing was a real effect. The results initially replicated those of White suggesting that facial expression recognition is more impacted when first order configural processing is disrupted compared to second order, however, the follow up analyses revealed this difference to be not significant; therefore disagreeing with the conclusions of White.

In experiment five the results of the previous studies conducted in the series were investigated, by changing the task from a matching paradigm to a recognition task for all six expressions. Again, the same first and second order manipulations were applied to each of the expressions, but in experiment five participants were asked to say which expression a face was portraying. This experiment also provided a confirmation of whether the results obtained in experiment four reflected a real effect or not. The results indicated that whilst recognition accuracy was not affected by either the first or second order manipulation for any of the expressions, reaction times were impacted. Longer latencies were observed for the expressions of anger and surprise when first order information had been disrupted, suggesting that these expressions may be more reliant upon this mode of processing than the second order one. However, the expressions of disgust and fear also showed the same pattern of results (although not significant) indicating that these expressions may also be more reliant upon first order information, and possibly indicating that the effects observed so far were not evidence of featural facilitation but rather an impact on the type of configural information. Again, however, a comparison of the accuracy data for these expressions revealed no effect on recognition for these expressions, indicating that first order configural processing was not more important for these expressions. Further, recognition rates remained high under both types of manipulation, indicating that another form of processing could be used when the primary method was disrupted; again it is suggested that this mode is featural processing; this suggestion is also supported by the reaction times being very similar to those found in other studies in the thesis where only featural processing is available.

As the results gathered from the first five experiments indicated that facial expressions are more reliant upon configural processing, due to the large disruptive impacts observed with configural manipulations, experiments six and seven returned to look at the change between configural and featural processing. Research on facial identity processing has investigated the impact of rotating faces from upright to inverted to ascertain whether the mode of processing changes in a dramatic switch at particular angles of rotation, or whether there is a general decline in the ability to use the configural processing strategy. The results of these investigations have not been conclusive. Some researchers find evidence of a switch between the configural and featural modes (Sjoberg & Windes, 1992; Sturzel & Spillman, 2000; Murray, Yong & Rhodes, 2000) with others finding a general decline in the use of configural processing (Collishaw & Hole, 2002; Lewis, 2001; Lewis & Glenister, 2003). So far, the implications for facial expression research had not been investigated.

Experiment six therefore provided the first exploratory investigation into the impact of rotation on facial expressions. In this study participants were asked to determine whether a face was portraying a neutral facial expression or an emotional expression as it was rotated through 360 degrees. It was hypothesised that as facial expressions were rotated from upright there would be a gradual decline in the use of configural processing, and a gradual increase in the use of featural processing; which would be shown by an increase in reaction time as participants changed from primarily using fast processing (configural) to the slower mode. Based on the previous five experiments it was suggested that all six expressions were processed using configural processing, with some seemingly equally processed featurally, and that even when the configural mode was disrupted, recognition remained high. Therefore, it was hypothesised that both modes of processing were available to use with faces and as they were rotated a gentle change between the two systems specialised for upright (configural) and inverted (featural) expressions would occur. The results confirmed the hypotheses. As expressions were rotated reaction times increased in a linear fashion, indicating a gradual change, rather than a switch in processing.

Experiment seven provided a confirmatory study for experiment six, as it investigated the impact of rotation on the recognition of facial features. Previous research had suggested that features are non-orientation specific (Farah, Wilson, Drain & Tanaka, 1998; Freire, Lee & Symons, 2000; Searcy & Bartlett, 1996; Tanaka & Farah, 1993; Tanaka & Sengco, 1997) and are therefore not impacted by inversion or rotation. Experiment seven researched this claim for facial expression features by asking participants to determine whether a feature (eyes or mouth) was portraying a neutral expression or a featural one, at either 0 degrees rotation (upright) 90 degrees or 180 degrees (inverted). It was reasoned that if featural processing is employed when faces are inverted, there should be very little or no impact of rotation on expression features. The study confirmed this hypothesis, and provided evidence that featural processing is not sensitive to inversion and is therefore most likely to be the mode of processing employed with inverted faces.

Overall, the results of the experiments conducted in this thesis provide evidence that the six basic facial expressions of emotion are primarily processed configurally, with the expressions of disgust and fear also being processed successfully with the featural strategy. Further, when the configural mode of processing is disrupted the featural mode becomes dominant and allows recognition to remain high. The fact that in all seven experiments recognition remained above chance level for all six expressions would suggest that although the primary processing strategy is configural, featural processing is also highly developed for all expressions. Whilst these conclusions have also been suggested by previous research, there have typically been problems comparing between studies, due to different stimuli being used, different methodologies and inconsistencies with the facial expressions employed. The studies in this thesis have replicated some of the most robust tests of configural and featural processing and have provided a clear and comparable investigation into the influences of configural processing on facial expressions whilst using a consistent set of expressions and stimuli and a consistent methodology. Thus, making the area of facial expression research more comparable to that of facial identity, to which it has always been compared but without the same level of reliability and validity as found in facial identity research.

40 IMPLICATIONS FOR THEORIES OF FACIAL EXPRESSION PROCESSING

The main aim of the thesis was to provide a further investigation into the strategies involved in facial expression processing. As the results of the experiments in this current thesis have far reaching implications for the study of facial expressions of emotion, this section of the discussion aims to review the main findings of the present research in consideration of current understandings of how facial expressions are processed.

Whilst research on facial identity recognition and processing has been prolific, research on facial expression perception has been somewhat sporadic. Few researchers have dedicated their research career to investigating facial expressions (in comparison to numerous who have dedicated their academic career to facial identity), which has resulted in a number of potential "theories" of facial expression perception being borrowed from the identity literature and some being suggested based on research findings. However, the lack of consistent research programmes investigating these theories has been a distinct problem for facial expression theories on how facial expressions are processed. As outlined in chapter one there are two highly developed theories of face processing, the dual mode hypothesis and the holistic hypothesis. Whilst the dual mode hypothesis has received a large amount of research interest from facial expression researchers, the holistic hypothesis has not. Perhaps this reflects the fact that the holistic hypothesis has largely failed to gain unanimous support in the facial identity literature, with researchers typically conceding that their data could be taken as support for the dual mode hypothesis. The specific facial expression hypotheses which have been proposed are the part based model (Ellison & Massaro, 1997), the configural hypothesis

(Parks, Coss & Coss, 1995; which can be seen as a version of the dual mode hypothesis), a specific first order hypothesis (White, 2002) and as a compromise between the configural and part based models, McKelvie (1995) and Prkachin (2003) proposed a distinction based on individual expressions.

The results from the current thesis have significant implications for a number of these proposed theories of facial expressions. Problems with the part-based model of expression perception (Ellison & Massaro, 1997) were highlighted in chapter one, and it cannot explain the findings of the current research. Ellison and Massaro (1997) proposed that rather than faces being processed in a gestalt (as in the holistic hypothesis) they are represented and identified by individual expression features, for example, the smiling mouth of happiness. However, in experiment one when employing inverted Thatcher faces, the individual expression features were presented upright on the screen (in an otherwise inverted face) and yet participants' performance on all six expressions was reduced by this manipulation. With the expressions of disgust, fear and sadness it was found that participants could recognise these expressions with more accuracy than if the whole face was unmanipulated and inverted. However, this does not provide clear evidence that these expressions are part based, as inversion of normal faces drastically reduced participants' ability to recognise expressions (in experiments one and three) even though the featural information remained intact. Indeed, in all experiments other than the blur manipulation employed in experiment three, there was no manipulation of the featural information Ellison and Massaro propose to be crucial, and yet recognition accuracy and response time latencies clearly show that participants had difficulty recognising the expressions. The lack of evidence found for this model of expression perception in previous research and the current thesis suggest that the effect found by Ellison and Massaro is most clearly explained as an artefact of the design and methodology employed (Calder et al. 2002b). The fact that this research relied upon the manipulation of two facial features, eyebrow deflection and mouth deflection, to test the discrimination between two facial expressions of emotion, happiness and anger, could have caused specific processing strategies to be employed. For example, the two manipulated features were the only ones present in the face, therefore, Calder et al. (2002b) point out that it is possible that these features were processed as independent features and therefore what the results show are that eyebrow deflection and mouth deflection are represented as parts and processed featurally. The fact that the stimuli were also computer generated adds to the confounds, as no global changes occurred in the faces, for example, the wrinkling of the forehead through eyebrow deflection or the changes observed in the cheeks and chin when a mouth is deflected in a real life face. Therefore the results of the research become much more focused and onto the processing of two part shapes in a face context, rather than facial expression perception per se.

The configural hypothesis for facial expressions (Parks, Coss & Coss, 1995) is actually a variation of the dual mode hypothesis. Parks et al. asked participants to rate the pleasantness of individual schematic features which were either placed into a face context or not; and found that they could alter participants' judgements of these stimuli when they were placed into a face context, but not when presented alone. The authors suggested that configural processing will override any instructions given to process an expression, or part of an expression, featurally; therefore proposing that expressions are processed configurally. In essence this is an adaptation of the dual mode hypothesis, which suggests that facial expressions are processed via two processing strategies, configural or featural. When configural information and processing is available it will be the dominant processing strategy, however, when this strategy is precluded (for example, by removing configural information and presenting isolated features, as Parks et al. did) featural processing will be employed as the primary processing mode. This theory explains the results of the Parks et al. (1995) study with much more ease than the configural hypothesis does. Again, the configural hypothesis cannot explain all of the findings for the present study, as featural processing was involved in a number of studies and individual features were recognised in the context of a face (experiment one, Thatcher faces) and when featural information was removed from a face context (experiment three, blur manipulation), decrements in performance were observed. Therefore, it seems sensible to incorporate the configural hypothesis into the dual mode hypothesis, as it is not fully ruling out the use of featural processing.

The dual mode hypothesis has perhaps received the most support for facial expression processing and it is proposed that an extended version of this hypothesis could account for the current findings in this thesis. The dual mode hypothesis, as described above, allows for the possibility that facial expression perception uses both configural and featural processing. The hypothesis is based on three assumptions (Ingvalson & Wenger; 2005): 1) configural and featural information are both available in a face, regardless of the orientation of that face; 2) the configural and featural information are processed independently; 3) the orientation of the face will determine which of the two sources will dominate the processing. The experiments in the current thesis support all three of these assumptions. As the inversion effect is taken as a robust manipulation which disrupts the ability to configurally process faces and expressions, the fact that in both experiment one and three, a reliable inversion effect was found for expressions, is evidence that configural processing was disrupted. In support of the first assumption of the dual mode hypothesis, even though configural processing had been severely disrupted, the expressions were still recognised with above chance accuracy, indicating that featural information was available and being processed. Further, in both of these experiments the inverted faces had no other manipulations applied, therefore, neither featural nor configural information had been removed or interfered with in the faces; providing further support.

Experiment six also provides support for the first assumption: as faces were rotated from upright to inverted, no information was removed or disrupted and the expressions were still recognised, both featural and configural information were still available in the face, yet only featural processing was occurring, due to the angle of rotation (evidence for assumption three).

The second assumption requires evidence that both configural and featural information can be processed independently. Previously Macho and Leder (1998) provided evidence for facial identity research that individual facial features can be represented and stored in memory, thus they can be processed independently from configural information - they do not require a face context to be recognised. Experiment seven in the current thesis also found that individual facial expression features could be discriminated, even at various angles of rotation, indicating that featural information was being processed independently of configural. Further, experiment three (blur) indicated that even when featural information had been highly degraded, the configural information could still be independently processed, for some of the expressions. Conversely, experiment one provided evidence than when configural information has been disrupted, in the upright Thatcher face, the use of featural information still allowed above chance recognition of the original facial expression being portrayed by the features. Thus, the second assumption of the dual mode hypothesis is also supported by the present studies.

Finally, the third assumption, that the orientation of the face will determine which of the two sources will dominate the processing, has been supported by all studies in the thesis which have included an orientation manipulation. In experiment one by employing both normal and Thatcher faces in the inverted orientation it was possible to assess which mode of processing was being employed. The reduction in recognition accuracy to normal inverted faces compared to normal upright faces indicated that configural processing had been precluded, whilst the above chance recognition supported the hypothesis that featural processing was still available. In the Thatcher inverted faces, even though the whole face was inverted, thus disrupting configural processing, featural information remained upright with featural processing available, with this even facilitating the recognition of some expressions. Again, experiment three provided a reliable inversion effect. Finally experiment six provided robust evidence that as an unmanipulated face is rotated from upright, so that no change in either the configural or featural information takes place, the processing strategy changes from the fast, configural mode, to the slower, featural mode. This provides direct support for the third and final assumption of the dual mode hypothesis.

Returning to the theories of specific facial expression processing, evidence has been not been found in the current research for the propositions made by White (2002), McKelvie (1995) and Prkachin (2003). White proposed that one way to conceive of expression processing is that although a primarily configural strategy is employed, this strategy has two components: first and second order configural processing, which he manipulated using an eye displacement technique. Experiment four in the current thesis found initial support for the claims by White, that expressions are more based on first order configural processing than second order. However, when examining the results carefully, there was no difference between first and second order manipulations, indicating that expressions are not more reliant upon this specific form of configural information. In experiment five the results were extended to investigate the specific effects of first and second order configural processing on the six individual facial expressions of emotion. As discussed in the previous section, no evidence was found that individual expressions were more reliant upon either first or second order processing. The reaction time data in experiments four and five closely resembled those that had been found elsewhere in the thesis when configural processing had been precluded, leaving only featural. Therefore, it is suggested that under the manipulations, participants processed the altered faces featurally; again, this is explained by the dual mode hypothesis and lends support to the theory.

Finally, McKelvie (1995) and Prkachin (2003) suggested that certain facial expressions may be more reliant upon featural information than others, specifically suggesting happiness and surprise were more featural. Whilst the present thesis did not find support for these conclusions, it was found across three experiments that the expressions of anger, disgust and fear may be as reliant upon featural processing as configural. It cannot be concluded that these are "featural" expressions, as experiments one, two and three provide evidence that they were disrupted by manipulations that disrupted configural processing. Therefore, they are not wholly configurally or featurally based, but rather are equally reliant upon these forms of processing. A simple extension to the dual mode hypothesis for facial expressions could account for this difference, by including a fourth assumption: 4) the individual facial expression of emotion being investigated will determine which processing mode dominates, under certain conditions.

Therefore, it would seem that the results of the current thesis are both fully explained by the dual mode hypothesis and also provide evidence for the three assumptions of the theory. It is therefore proposed that the dual mode hypothesis for face processing should also be extended to explain the processing of facial expressions of emotion.

40.1 Anger, Disgust and Fear

The consistent effect of featural processing found with these expressions suggests that there is something special or interesting about these emotions. It is interesting to reflect on why the 'featural' effect should be seen on these three emotions and not on happiness, sadness and surprise. It is hypothesised that there is a potential evolutionary basis to the effect observed with these expressions.

At the most basic level all three expressions represent intuitive negative emotions, however, in addition to these the emotions are usually experienced in relation to an external event or object (either at or of something/someone). For example, disgust may be displayed at the taste of rotten food, anger to an enraging situation, fear of a life threatening object and situation – being held at gun point). There is an obvious evolutionary advantage to being able to recognise these expressions quickly (configurally) but also to be able to recognise them featurally. For instance, if only part of an angry face could be seen it would still be a necessary survival strategy to be able to recognise the emotion. This would not be imperative for the expressions of happiness, sadness or surprise, as their underlying emotions do not signal danger, harm or threat; whereas the expressions of anger, disgust and fear do.

This evolutionary advantage would also concur with research regarding the development of the ability to recognise facial expressions. The expressions of anger, fear and disgust have been found to develop at very young ages. Rosensten and Oster (1988) report that the facial expression of disgust can be observed in infants within two hours of birth, indicative of the innate, intuitive nature of the expression and emotion. Similarly for anger and fear it has been found that 4 – 6 month old infants can readily discriminate and recognise these expressions when posed by several different actors, not just their primary and immediate care givers (Serrano, Iglesias & Loeches, 1992). This suggests that these expressions have innate, functional properties. Convergent with the idea that these three expressions share a commonality are research findings from neural studies of expression recognition.

In recent years a wealth of knowledge has been published on the neural substrates for facial expressions of emotion, interestingly, with the majority of studies focusing on the expressions of anger, disgust and fear (e.g. Adolphs, Tranel, Damasio & Damasio, 1995; Blair, Morris, Frith, Perrett & Dolan, 1999; Calder, Keane, Manes, Antoun, & Young, 2000; Lawrence, Calder, Andrew, McGowan, & Grasby, 2002). Whilst researchers now agree that there are distinct neural areas for all six of the basic expressions, research by Sprengelmeer, Rausch, Eysel and Przuntek (1998) found that all three of these expressions equally activate an area in the left inferior frontal cortex (Brodmann area 47). They therefore concluded that whilst there are specific individual neural pathways involved in the processing of each of the expressions, they also project along a shared pathway to the inferior frontal cortex. It is possible that the shared pathway for these three expressions could be responsible for their disposition towards featural processing.

It is therefore hypothesised that the expressions of anger, disgust and fear share a functional commonality, underpinned by their evolutionary and neural development. Of course, this hypothesis raises further questions for research such as investigating the commonalities between happiness, sadness and surprise; and investigating why some second order emotions also seem to have distinct facial expressions (for example, interest and pride) but other extremely intense emotions do not have universally accepted expressions (for example, jealousy and lust).

41 IMPLICATIONS OF THE CURRENT RESEARCH FOR FACIAL EXPRESSION RESEARCH

Whilst the findings of the present thesis add new knowledge to the area of facial expression research, they also have implications for research which has already been conducted. The main implication of the current findings is the different effects observed across facial expressions of emotion. As discussed throughout this thesis, a major criticism of facial expression research is the inclusion or exclusion of certain facial expressions of emotion. Apart from experiment two where a specific composite effect was investigated for expressions where claims had previously been made to suggest the expression were primarily featural or configural, all six of the basic expressions were always employed. Therefore, throughout the thesis the criticism of past research, that not all expressions have been employed, has been addressed. Further, in the majority of the studies the impact of manipulations on each of the six expressions has also been investigated, thus avoiding the problem of making generalised conclusions based on data for different expressions.

Whilst the current research has shown that facial expressions are primarily processed configurally, it has also shown that for some expressions featural processing is equally important. Therefore, the decision to exclude any of the six basic expressions of emotion should be considered carefully, especially if the research focus is to investigate how facial expressions are processed.

It is suggested that at the very least all future research should include the minimum of the six basic facial expressions of emotion. Further, where possible, and it is difficult to conceive of studies in which it would not be, the investigation of the impact of any experimental effect on each individual facial expression should be conducted. Finally, due to research on the happy face advantage (Endo et al. 1995) and the results obtained for the expression in the present thesis, it is suggested that careful consideration is given to studies which look at facial expressions per se, and do not investigate individual expressions, as this expression may possibly skew the data. Therefore, the use of the expression in research should be considered, especially when the expression is being employed to research other issues, and not expression recognition. For example, the happy expression is primarily used as the stimuli for creating Thatcher faces (Bartlett & Searcy, 1993; Murray, Yong & Rhodes, 1993; Sturzel & Spillman, 2000) which may well be one of the reasons for the effects often observed with this manipulation, not simply because of the manipulation itself.

Therefore, it would be advantageous for research which has already been produced on the processing of facial expressions to be carefully considered and reviewed, and possibly replicated to include a consideration of the impact of all facial expressions involved.

42 LIMITATIONS OF THE RESEARCH

As with any research there are areas for improvement with the current thesis and limitations of what could be achieved. One of the main considerations is that of participant selection. Due to the size of the academic department in which the research was conducted many of the participants in the present studies participated in more than one of the experiments. Whilst this is not a problem in itself, and often occurs in research, it is important to acknowledge that some practice effects may have occurred for some participants. It is possible that participants, who had taken part in all, or the majority of the experiments, could have become practiced at recognising the facial expressions, which could have reduced the impact of manipulations upon these expressions. However, when looking at the recognition data across the experiments there does not seem to have been a marked increase in recognition rates, thus indicating that practice effects may not have occurred.

Further participant factors also form a limitation to the research. The only inclusion/exclusion criteria applied to participant selection was that of normal or corrected to normal vision and the ability to speak/read English (as the consent forms and responses were written in English). However, whilst conducting the research it became apparent that not all participants were familiar with the six basic facial expressions of emotion and/or not familiar with the labels for the expressions. Prior screening of participants to check for recognition of each of the basic expressions and to investigate the way in which participants would have labelled each expression, may have reduced any errors which were due to a discrepancy between the participants recognition/labelling of an expression and that suggested by research.

Participant availability was also problematic and is reflected in the analyses throughout the thesis. The sample size included in any study will impact upon the observed power of the results and the effect size. Unfortunately, large numbers of participants were not available for the research presented in this study and thus the power and effect sizes were reduced. To maintain a practically acceptable level of power (0.8) as recommended by Cohen (1988) the number of participants should equal at least 70 (when aiming for a small to medium effect size). This sample size was just not possible to achieve for this thesis, however, in each of the seven experiments reported the sample size was larger than that reported in previous research and therefore still represents a valid exploration of the experimental questions, although it is acknowledged that the power levels are not equal to those recommended.

Finally, the use of the Ekman and Friesen (1976) *Pictures of Facial Affect* stimuli set may be seen as a limitation by some researchers. There are some problematic issues with the stimuli set such as the fact it was produced in the 1970's and is quite dated, the expressions were produced by carefully training actors to pose each emotion, the pictures are black and white, show emotions near or at the peak of intensity, are posed and not spontaneous and of course, only show the

Ekman and Friesen proposed six basic facial expressions of emotion. Carroll and Russell (1997) questioned the ecological validity of the expressions and suggested that it may be quite low as they represent static expressions. Carroll and Russell propose that in their natural, spontaneous context, the expressions would be moving and therefore the Ekman and Friesen set do not represent naturalistic expressions. Morrison, Bellack and Mueser (1988) add to the debate by suggesting that the expressions would not be seen outside of a laboratory environment, as such highly intense expressions are not naturally produced.

However, despite critical evaluation of the *Pictures of Facial Affect* stimuli, their continued use in facial expression research suggests that they are both useful and reliable. Their use in the present research made comparison with prior research on facial expressions of emotion possible, as they form the stimuli for the majority of facial affect studies. They also overcome the criticism of other types of stimuli such as line drawings or photo-fit expressions/faces, as they do provide a more naturalistic representation of facial expressions, they include configural and featural information and they do not require preliminary ratings studies to be conducted, as this information is already available. The majority of researchers therefore agree that they still provide the most comprehensive set of exemplars of photographic images of facial expressions; which is supported by the high inter-rater reliability found across 21 countries (Boucher & Carlson, 1980; Ekman et al, 1987; Izard, 1971).

43 DIRECTIONS FOR FUTURE RESEARCH

Whilst facial expressions have been studied for over 300 years, there still remain a number of unanswered questions about them; this is largely due to the area playing "catch-up" with that of facial identity. It is therefore hoped that this thesis has gone some way to answering some of the questions which do remain regarding the processing basis of facial expressions. Although of course, questions do still remain and this thesis has raised yet further questions for consideration. Some potential areas for investigation will be outlined.

The rotation studies conducted as part of this thesis were extremely exploratory as the manipulation had never been employed with facial expressions previously. Whilst the findings in the current study provide invaluable information on the processing of facial expressions, they do not provide an explanation of what happens to each of the six individual expressions with rotation. From the other studies conducted in the present research it is obvious that not all facial expressions are processed in exactly the same way and it is therefore possible that rotation will have different effects on each of the expressions, or on groups of expressions. Therefore, future research should investigate the impact of rotation on each of the six basic expressions.

It is acknowledged that there are many different facial expression stimuli sets available to researchers, not just the Ekman and Friesen (1976) faces employed in the current thesis. However, it was important to conduct this research with a highly valid and reliable stimuli set. Future research could take advantage of some of the new sets of stimuli which have been produced, which contain many more expressions than are included in the Ekman and Freisen (1976) basic set of emotions. For example, the facial expressions of emotion: stimuli and tests (York, Perrett, Calder, Sprengelmeyer & Ekman, 2002) which includes numerous variations based around each of the six basic expressions; or the use of moving stimuli to investigate the interaction between movement and configuration. There remain many possible expressions and forms of expression to be researched.

There is an extremely active research area which investigates the processing of facial expression in clinical population, such as individuals with schizophrenia, autism, personality disorder etc, and forensic populations, most predominantly individuals who have committed violent acts. Often this area suffers the same criticism as all facial expression research with regard to expressions being included and excluded. Again, this research very often fails to incorporate even the six basic facial expressions, with studies investigating expression perception in forensic populations often only employing anger expressions. The findings of the current thesis have obvious and far reaching consequences for such research, particularly as very often the results of such studies are applied in clinical and forensic settings to help people recognise emotions in others. Therefore, research with clinical and forensic populations should take into account the current findings with regard to individual expressions and the way in which they are processed. Research should be conducted using all six of the basic expressions in order to ascertain the individual differences which may be apparent for some populations, based on their use of configural and featural processing with different expressions.

44 APPLICATION OF THE FINDINGS

Facial expression stimuli are employed in a number of applied settings and the current research has obvious implications for these applications.

44.1 Facial Identity Software

Face recognition software is now a major industry. In many of the older recognition systems faces were recognised on the basis of an overall configuration of the face. However, new systems measure specific points on the face to make recognition more accurate. One such system is Identix's FaceIt software. This 3D recognition system measures distinguishable points on a face such as the distance between the eyes (interocular distance), width of the nose, depth of the eye sockets, shape of the cheekbones and the length of the jaw bone. The new systems are now much more sensitive to recognising faces under variant conditions, such as changes in texture, luminance and facial expressions. However, they still rely on a point by point comparison between images, which the current research has shown is not necessary with facial expressions. If the software were to incorporate an algorithm for identifying the configural and featural properties of each of the basic expressions, then recognition under variable expressions could be made much more efficient. This would be particularly important for high security systems such as prison entrance systems.

44.2 Clinical and Forensic Research

As mentioned above, there is a vast array of research conducted on the recognition, perception and projection of facial expressions of emotion in both clinical and forensic populations. Research in clinical and forensic populations is typically applied research, where the aim of the investigation is to find ways to help individuals recognise emotional facial expressions and therefore the underlying emotion other people are feeling and expressing. For example, Simon Baron-Cohen and his research team (Baron-Cohen, Hill, Golan & Wheelwright, 2002; Golan, Baron-Cohen, Wheelwright & Hill, 2006) have had some success with teaching children and adults with a diagnosis of autistic spectrum disorder to recognise emotion through the recognition of facial expressions of emotion.

Whilst the current research has found that there is an overriding predisposition to process facial expressions of emotion configurally, it has also provided evidence that there are variations in recognition also. Therefore, any research which is trying to help people to learn how to process expressions should take into account the current findings. The application of the current findings could help to teach people how to recognise configurations and features, and thus the configural and featural processing strategies for each expression. This could then be extended to the recognition of subtle changes between expressions.

45 SUMMARY

The research conducted in the current thesis demonstrates that facial expressions of emotion are processed via two methods which are specialised for the processing of faces and facial expressions. These are the configural processing strategy and the featural. Under normal viewing conditions both processing modes are available and used to recognise facial expressions, however, when either mode is disrupted the other can be used. Whilst both modes of processing are available, it is the configural mode which is the dominant processing strategy. However, the research also investigated the impact of both processing strategies upon the identification and recognition of individual facial expressions, to address criticisms levied at facial expression research. The results demonstrate that for some expressions featural processing is equally as important as configural. These expressions appear to be anger, disgust and fear, whilst happiness, sadness and surprise are processed via the dominant, configural strategy.

The current research therefore provides further understanding of how individual facial expressions of emotion are processed. Furthermore, the results are can also be consolidated with the dual mode hypothesis for facial identity processing, and provide evidence that this model can be applied to facial expressions. With the addition of one more assumption to the model, it can adequately explain the present findings with individual expressions.

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